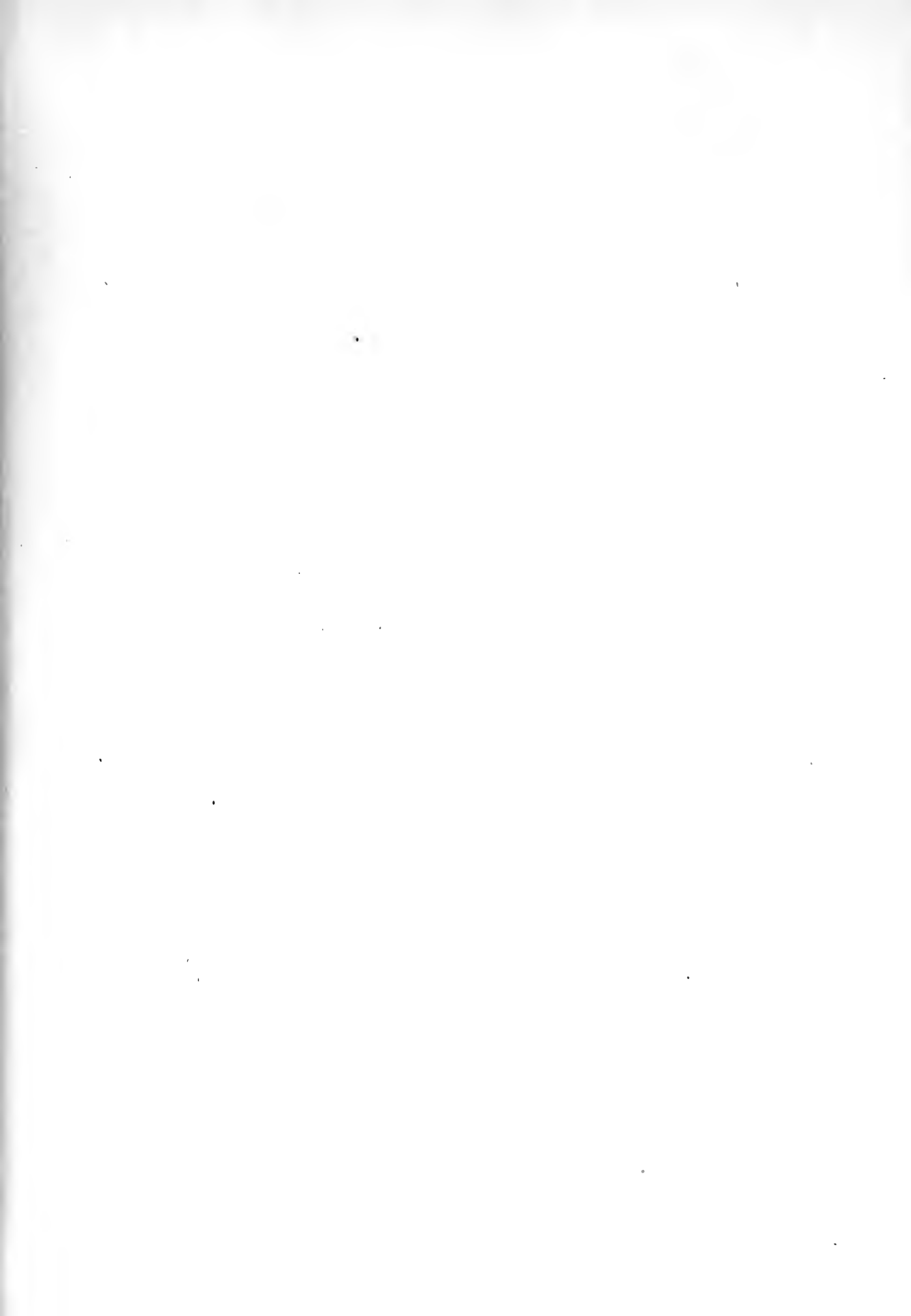


INVESTIGATION OF SENSITIZATION OF
BRITTLE COATINGS

BENJAMIN T. DIEBLE AND
JOE R. WILSON

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INVESTIGATION OF SENSITIZATION
OF BRITTLE COATINGS

A thesis
presented to the faculty of
Rensselaer Polytechnic Institute
in partial fulfillment of the
requirements for the degree of
Master of Civil Engineering.

by

Benjamin T. Dibble

and

Joe R. Wilson

Troy, New York

September, 1948

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CONTENTS

Acknowledgement	1
Object	2
Theory and Use of Brittle Coatings	4
Procedure	10
Conclusions	22
Recommendations	26
Data	27
Bibliography	66

ILLUSTRATIONS

Fig. 1 Stresscoat Coating Selection Chart	52
Fig. 2 Stresscoat Creep Correction Chart	53
Fig. 3 Sensitivity vs. Cooling Time, Coat 1206	54
Fig. 4 Sensitivity vs. Cooling Time, Coat 1208	55
Fig. 5 Sensitivity vs. Cooling Time, Coat 1209	56
Fig. 6 Cantilever Loading Device (before load)	57
Fig. 7 Cantilever Loading Device (during load)	58
Fig. 8 Calibration Scale	59
Fig. 9 Drying Graze	60
Fig. 10 Effect of Dye Etching	61
Fig. 11 Variation of Sensitivity by coat thickness	63
Fig. 12 Variation of Sensitivity by coat selection	64
Fig. 13 Cooling Curve for Despatch Oven	65

1	Introduction
2	Object
3	Theory and use of Helium Compounds
10	Preparation
20	Characteristics
25	Physical Properties
27	Chemical Properties
30	Biography

LIST OF FIGURES

Fig. 1	Diagram showing Helium in Gases
Fig. 2	Diagram showing Helium in Gases
Fig. 3	Diagram showing Helium in Gases
Fig. 4	Diagram showing Helium in Gases
Fig. 5	Diagram showing Helium in Gases
Fig. 6	Diagram showing Helium in Gases
Fig. 7	Diagram showing Helium in Gases
Fig. 8	Diagram showing Helium in Gases
Fig. 9	Diagram showing Helium in Gases
Fig. 10	Diagram showing Helium in Gases
Fig. 11	Diagram showing Helium in Gases
Fig. 12	Diagram showing Helium in Gases
Fig. 13	Diagram showing Helium in Gases
Fig. 14	Diagram showing Helium in Gases

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B. T. Dibble

J. R. Wilson

1

1911

The authors wish to express their appreciation to
Professor R. H. Tietjen for his suggestions and helpful
criticism. Grateful acknowledgment is also made to
and A. J. Tietjen for their help in conducting the
of the work presented in this paper.

R. H. Tietjen

A. J. Tietjen

OBJECT

This work has been experimental in character. The authors felt that a research thesis would be of greater interest and value than one of pure design since much design work has been covered in the classroom. This research problem was approached with two general objectives in view: first, to learn and to understand the problems and procedures connected with any research problem; and second, to investigate some problem, the solution of which might prove useful in the scientific field.

This subject was picked to give a feeling of pioneering in an undeveloped field. As far as the authors can ascertain, no experimental results have been published on the subject of sensitization of brittle coatings. G. Ellis advances the claim that "If dye etchant is applied to the surface of the brittle coating while the structure is under load, the coating will be sensitized by 0.0006 in/in strain..... Where there is no appreciable stress on the surface, the dye etched patterns will appear as haphazard craze marks. However, where there is any appreciable amount of strain the craze marks will straighten themselves out into a definite pattern."(1) Also, "The results obtained by sensitization are to be considered wholly qualitative in character, their primary function being to obtain direction of principal stresses"(2).

In the field of stress analysis, if this sensitivity of the brittle coating could be increased such that it would be possible to read strains of the order of 0.0002 in/in with consistency, it would greatly aid and encourage the use of the brittle coating method of stress analysis. The general objectives have been stated, but the specific investigation is to check the manufacturer's claim for the

effectiveness of dye etching under load and to undertake a comprehensive investigation of the effect of heat treatment.

The authors will draw conclusions from the results and will make suggestions for the continuation of the work. Any irregularities that appear will be accompanied by explanations of the probable causes.

effectiveness of the study under test and to determine the nature

and extent of the effect of the treatment.

The results of the study are given in the following table.

Table 1. Results of the study for the different treatments.

Table 2. Results of the study for the different treatments.

Table 3.

THEORY AND USE OF BRITTLE COATINGS

In 1932, the German scientists Dietrich and Lehr published the first recognized work on the use of brittle coatings for the indication of strains in the elastic range. In 1937, the first major investigation in this country was conducted by G. Ellis of Massachusetts Institute of Technology, and since that date there have been many improvements and modifications of the original technique, materials, and equipment. Of the many brittle materials which might be applied to stress measurement, the one most used today is a brittle resin in volatile solvent type lacquer material. The most widely used coating is a proprietary solution called "Stresscoat" which is manufactured by Magnaflux Corporation.

The coating is applied to the surface to be investigated by spraying rather than dipping or brushing because spraying is easier, and also because the peculiar property that small bubbles included into the coating improve the quantitative accuracy of the strain pattern formation. Best drying time is 18 to 24 hours. Stressing the surface of a structure by adding load causes the brittle coating to fracture when a certain critical value of tension strain is reached. From a quantitative standpoint, this critical value of the strain which just initiates pattern formation is the most important measurement which can be made with a brittle coating. Patterns run at right angles to the principal tension stress. "The brittle coating may be thought of as providing a large number of principal tension strain indicators with a minimum gauge length of 0.05 inch and with a workable range of approximately 0.0007 to 0.0012 in/in strain."(3)

Quantitative evaluation of the amount of strain is secured by calibration. A calibration strip of spring steel 12"x1"x $\frac{1}{4}$ " is sprayed and dried along with the structure under test. The most convenient

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It is suggested that the following be applied to the case of the individual who is not a member of the organization.

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12. *Chelodactylus* n. sp.

method of calibration devised is a cantilever beam under known deflection loading. The loading rig (fig. 6 and 7) embodies an adjustment screw at the fixed end to bring the strip in contact with the cam and a cam of definite deflection. This deflection is such that the upper surface of a coating 0.004 inch thick on the test strip will receive the graduated amount of strain along the strip from a maximum at the fixed end to zero under the cam. The testing procedure is simply to place the coated and dried strip in the loading rig, adjust the strip so that it will just touch the bottom of the cam, and deflect the cam to its full extent. Reference marks can be made on the strip opposite the characteristic patterns being investigated. After release from the calibrator, the calibration strip is placed in a strain scale (fig. 8) which is marked off in terms of the strain imposed on the strip by the fixed cam deflection. Evaluation of the strains on a structure is made by matching the regularity of the crack patterns on the structure and on the calibration strip rather than by counting the number of lines per inch.

"Since the range of strain which can be evaluated is smaller than the range present on most structures another principle must be utilized in order to effect a complete analysis. If the assumption is made that Hooke's Law holds over the entire structure, then local strains at different values of loading on the structure can be measured and by simple proportion one can interpolate or extrapolate all local strains to correspond to any value chosen. In general Hooke's Law is a good approximation to actual performance, and, in practice, structures which seriously deviate from it are fairly easy to recognise."(3)

"On areas of moderate strain concentration values of principal tension and compression strains may be estimated within an error of about fifteen percent. The direction of the principal strains is indicated with exceptional precision."(3)

Despite their brittleness the coatings are quite plastic, and the amount of strain necessary to crack a coating varies with the time taken to reach the load. Correction for creep is therefore an important factor in obtaining quantitative measurements. Correction may be had either by loading all bodies involved in the test in the same length of time, or else by loading at a constant rate, observing the time at which patterns first appear, and correcting all values to a common time of loading by means of a chart of creep curves (fig. 2).

The main disadvantage of Stresscoat is that the resin materials are sensitive to temperature variations and therefore should be used where the temperature does not vary more than 50°F during the loading cycle. Because the coatings are so sensitive to temperature and humidity, it is necessary to use different coatings to obtain the same degree of sensitivity (i.e., the amount of strain necessary to initiate pattern formation) under different weather conditions prevailing on different tests. For various temperatures and humidities the manufacturers of Stresscoat have developed a series of numbered coatings, and for a given temperature and humidity condition there is a certain optimum coating. Over twenty coatings are available, so that for any weather condition there are coatings of several strain sensitivities.

A uniformly bright background is a great help in observing the stress pattern easily. It also aids in applying the brittle coating by supplying a uniform background against which the thickness of the brittle coatings gives a characteristic color. An aluminum pigmented undercoating provides an excellent background. It is possible to apply the undercoating and have it dry sufficiently within fifteen minutes to cause no adverse effect on the brittle coating.

A red dye etchant solution serves several useful purposes.

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Formulated of solvent with a heavy concentration of organic dyes, the etchant reacts on the surface of the brittle coating in a manner similar to acid on steel. The organic solvent etchant preferentially attacks any cracks whether visible or invisible to the eye. The red dye helps to delineate the pattern by working its way into the strain pattern and coloring the cracks red. This is especially helpful for making photographs of the pattern because the contrast is not sufficient when the piece has not been dye etched. In the OBJECT the authors have included another use for dye etchant recommended by the manufacturer, the use of the etchant to sensitize the coating.

The following is an outline of the usual steps in an ordinary Stresscoat analysis:

PREPARE SURFACE.

Remove loose scale, grease, and paint.

APPLY UNDERCOATING.

Spray aluminum undercoating on structure to be investigated and on calibration strips. Allow 15 minutes to dry before proceeding.

SELECT COATING.

In order to obtain satisfactory results and know the quantity of strain indicated by the initial formation of strain patterns, it is necessary both to select the proper coating and to calibrate it for every test. Coatings are selected for conditions prevailing at the time and place where drying and testing will be done. The wet and dry bulb temperatures are measured by means of a sling psychrometer. Using these readings the proper coating is selected from the Coating Selection Chart (fig. 1). The coating number which lies in the space between two curves where the intersection of the two temperatures falls is the optimum coating and is best for average use. This coat will

have a sensitivity of 0.0007 to 0.0008 in/in. Each coating under its designated or optimum conditions acts the same as all others under their optimum conditions. If a more sensitive coating is desired, the next higher number coating should be used. Conversely, lower number coatings will be less sensitive.

APPLY COATING.

Stresscoat is applied by spraying. The nozzle is held two to five inches from the work, and the gun is moved parallel to the work. As the spraying progresses, the color of the coating changes from apparently clear to a definite yellow to a light brown. The yellow tinge indicates the most desirable thickness, from 0.003 to 0.006 inch.

DRY COATING.

The structure and calibration strips are dried together under as near the same conditions as possible. Minimum drying time is six hours.

TEST STRUCTURE AND CALIBRATION STRIP.

Calibration strip is placed in the calibrator and loaded by the cam as previously explained. The load is removed and the strip is placed in the strain scale. The value of strain at the lowest pattern is the sensitivity. The structure is loaded and tested as desired, and the strain on the structure at the lowest pattern is the same as that on the calibration bar. Creep correction is made either by loading the calibration strip in the same length of time taken to apply the load on the structure or by loading the calibration strip in one second and correcting for the actual loading time by use of the creep correction chart (fig. 2).

DYE ETCHING

Dye etch after completion of test by brushing on etchant, wiping it off after one minute, and washing strip with etchant emulsifier. This enables results to be read more easily and more accurately, and also permits photographing the pattern.

The above is standard procedure. Any deviation from this technique by the authors will be discussed in another section.

and the results of the study.

This study was designed to determine the effect of the use of the computer on the performance of the task.

The study was conducted in a laboratory setting. The subjects were divided into two groups: one group used the computer and the other group did not.

The results of the study showed that the use of the computer significantly improved the performance of the task.

The study was limited by the fact that it was conducted in a laboratory setting and the results may not be generalizable to other settings.

The study was funded by the National Science Foundation.

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...STI SOLI VAS...

PROCEDURE

Before any tests were made, it was necessary to construct twelve extra calibration strips. They were made of spring steel 12"x1"x $\frac{1}{4}$ ", an exact copy of the calibration strips furnished with the Stresscoat equipment. After becoming fairly proficient in the use of the spray gun, the authors began the test of the dye etchant.

TEST 1.

The optimum coating was found to be 1205. Six strips were sprayed with this coat, three with 1203, and three with 1207. The coatings above and below optimum were tested to find the effect of the etchant on more and less sensitive coatings. The strips were placed in a cabinet to dry unaffected by air currents. After drying 24 hours, the bars were tested in the calibration rig according to the procedure set forth in the preceding section. While the bars were loaded, the lowest crack was marked and dye etchant applied. After all bars were stressed, marked, and etched, they were placed in the strain gauge and the readings recorded.

Viewed through a magnifying glass under strong light, faint craze marks oriented normal to the direction of principal stress were found in the etched specimens. The ends of these marks were very difficult to distinguish, and their value on complicated shapes seems questionable. The recorded value of sensitivity after etching is quite arbitrary. The sensitivity was increased from 0.0002 to 0.0004 in/in, and this process might have some qualitative value even though the quantitative results seem unreliable. The lowest sensitivity was found in the coat of 1207 as was to be expected, and the value was approximately 0.0004 in/in strain.

Twelve extra employees and a few more were hired to help with the work. The extra employees were hired on a temporary basis and were paid at the same rate as the regular employees. The extra employees were hired to help with the work during the busy season. The extra employees were hired to help with the work during the busy season. The extra employees were hired to help with the work during the busy season.

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TEST 2.

From the results of Test 1 the authors concluded that only optimum and higher numbered coatings should be used in further attempts to increase sensitivity by dye etching. Consequently, Test 2 was made with optimum coat 1205, 1207 and 1209. The drying and testing followed the same procedure as Test 1, and the results compared favorably with the results of that test. Dispersion is greater with the more sensitive higher numbered coatings, and the drying craze (as shown in fig. 9) made readings more difficult.

TEST 3.

This test was run as before, but coatings used were optimum 1206, 1208, and 1211, and two specimens of coat 1206 were dried 24 hours in the oven at 100 F. The heat-treated bars were removed from the oven, cooled in still air for 1 minute and 15 minutes respectively before testing. All bars were etched under load as before.

The air dried coatings compared well with those in preceding tests, but the specimens dried in the oven had a remarkable increase in sensitivity. Since the two cooling times differed so in sensitivity, the authors felt that the next test should be to determine the optimum drying time if such existed. In the 1 minute cooling time the coating had not reached room temperature, and after 15 minutes the equilibrium must have been more nearly approached.

The readings after etching were even more difficult to make than before. The etching time decreased markedly, and the etchant seemed more active on the baked coat although the amount of sensitivity increase was about the same as with air dried coatings. The coating which was baked and cooled 15 minutes gave a sensitivity of 0.00045 before etching and 0.00025 after etching.

TEST 4.

The optimum coating was found to be #1206. Twelve bars were prepared with this coating. Two were dried at room temperature for a standard, and ten were placed in the oven at 100 F. After 24 hours, the heated bars were removed and stressed after different times of cooling. Times used were 0, 2, 4, 5, 6, 8, 10, 12, and 14 minutes. The air dried bars were also stressed, and all bars were etched under load. The specimens tested immediately on removal from the oven were of approximately the same sensitivity as those dried at room temperature, and the sensitivity definitely increased as the time of cooling increased. The curve of Sensitivity vs. Time of cooling (fig. 3) seems to level off after about 6 minutes, and longer times show little or no increase.

TEST 5.

The optimum coating was found to be #1207. Six bars were prepared with this coating and six with 1209. Two of each were air dried, and the remainder dried in the oven at 100 F for 24 hours. The four baked specimens of coat 1207 were removed and stressed after cooling in still air for periods of 0, 10, 20, and 30 minutes, and those of 1209 were removed and tested after cooling for periods of 0, 5, 10, and 15 minutes. The results confirmed those of Test 4, except that the optimum period for cooling seems to be longer - about 15 minutes. The specimen of 1209 which cooled 15 minutes showed a critical strain of 0.00035, and the etching craze was off the scale.

TEST 6.

The optimum coating was found to be #1208, and twelve bars

TEST 6 cont.

were prepared with that coating. Two strips were air dried, and ten were dried in the oven at 100 F for 24 hours. The specimens were removed from the oven and cooled in still air at various rates in another effort to find the optimum time of cooling. Cooling periods used were 0, 3, 6, 9, 12, 15, 20, 25, 30, and 40 minutes. The cooling curve (fig. 4) shows the optimum time to be about 15 or 20 minutes. This coating gave the most sensitive specimen yet found. The strain gauge is calibrated only down to 0.0004 in/in and by extrapolating, these coatings were found to have critical strains of the order of 0.0002 in/in. For this reason and also to gain accuracy, the authors constructed a new cam for the calibration rig. Since the strain in a cantilever is directly proportional to the deflection, a cam giving half the deflection of the old cam would produce half the strain at any given point on the strip. A cam was made with one-half the eccentricity of the old cam, placed in the rig, and by means of deflection gauge, deflections were checked at points along the bent bar to prove that the deflection of any point had been halved. A value now read in the strain gauge is twice the true value of the strain on the bar at that point, and the range of the scale was now from 0.0002 to 0.0010 in/in. This new cam was used in all tests to follow.

TEST 7.

With the optimum coating 1207, twelve bars were prepared with 1209, and two dried at room temperature while the other ten were dried in the oven at 100 F for 24 hours. The oven-dried specimens were cooled for periods of 0, 3, 6, 9, 12, 15, 20, 25, 30, and 40 minutes to find the optimum cooling time for this coating. As with Test 6, the cooling curve for this test (fig. 5) shows the optimum time of cooling to be

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TEST 7 cont.

about 20 minutes. After this time the coating seems to be stable, and further cooling does not affect the sensitivity. The heat treatment increased the sensitivity from about 0.0010 in/in when air dried to about 0.0002 in/in when dried at 100 F and cooled to equilibrium. The accuracy of the strain gauge is much increased with the new cam of smaller eccentricity.

TEST 8.

Since the results obtained from heat treatment were so encouraging, and the results from dye etching under load were so discouraging, the authors deemed it expedient to turn their efforts entirely to the effect of heat treatment, and Test 7 was the last test where dye etching under load was used.

With the results from 100 F obtained, Test 8 was used to investigate the effect of a highertemperature of 120 F. The optimum coat 1206 was used as well as coat 1208. For any practical use, 1206 was found to be the better at this temperature with air cooling. While 1208 was more sensitive and gave less dispersion, the accompanying craze would make readings on a more complicated structure extremely difficult to determine. All readings were taken after cooling for a period of 20 minutes or more.

TEST 9.

It was decided that an investigation of other temperatures was in order, and the next chosen was 90 F. To give a comprehensive picture of the effect of the temperature used, four coatings were prepared: 1206, 1208, 1209, and 1211 with 1208 being optimum. In spraying

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[illegible]

.. 3023

[illegible]

•

It was decided that the following should be done:

1. The following should be done:

2. The following should be done:

3. The following should be done:

4. The following should be done:

5. The following should be done:

6. The following should be done:

7. The following should be done:

8. The following should be done:

9. The following should be done:

10. The following should be done:

TEST 9 cont.

these coats, it was found that the higher numbered coats were much more difficult to apply, mainly because they tended to dust unless the spray gun was held extremely close to the work. The lower numbered coats of 1206 and 1208 were relatively easy to apply, and it was possible to get a much more even and satisfactory coating with the lower numbered coats. The effect of 90 F was relatively small, giving perhaps a small increase in the sensitivity. Since the effect was so small, the remainder of the investigation was conducted at temperatures of 100 F or higher.

TEST 10.

The same four coats were used as in test 9, with 1208 again the optimum coat. A drying temperature of 110 F was used with air cooling. 1208 was the best coat. 1211 crazed so that a reading was impossible. 1209 was less sensitive than 1208, and it is believed that this was due to use of an old can of lacquer 1209.

TEST 11.

The series of four coats had not been tested at 100 F, and this was selected for Test 11. Coat 1207 was optimum for this test. All specimens were cooled in still air for 20 minutes, and 1211 gave the lowest critical strain with no crazing.

TEST 12.

It was desired to duplicate if possible the results of Test 6 and to prepare a curve of the effect of cooling time on sensitivity. This was done with the optimum coat of 1206, and a drying temperature of 100 F. The results confirmed those of Test 6 except as noted, and the curve of sensitivity vs. cooling time (fig.4) was plotted. Upon spraying for this test, the lacquer from the original can was exhausted

TEST 12 cont.

after nine bars had been sprayed, and the remaining three bars were sprayed with lacquer from an old can of Stresscoat. From the results obtained, this must have had a large effect upon the sensitivity because these three bars were entirely inconsistent with previous tests and with other bars of this test.

TEST 13.

The results from the preceding tests were so effective that it was believed that by using still higher temperatures and a slower rate of cooling, this sensitivity could be reached with coats of a lower regular sensitivity. With this in mind, coats 1201, 1203, 1205, and 1207 were used with 1207 being optimum. A drying temperature of 150 F was used, and the effects of air cooling and oven cooling were compared. For oven cooling, the oven was turned off, all vents were closed, and the oven was allowed to slowly cool to room temperature. The cooling curve for this condition is shown in figure 13. Cooling in air, 1205 crazed so that no reading could be taken, but cooling in the oven, it reached a sensitivity of 0.00015 in/in. It was interesting to note that this temperature had the effect of increasing the size and number of bubbles in the coating. This can be seen in fig. 14 if closely examined.

TEST 14.

From the preceding tests, it was apparent that each drying temperature had a definite numbered coat which would give a sensitivity on the order of 0.0002 in/in. It was decided to select four temperatures of 175 F, 150 F, 125 F, and 100 F and to determine the best coat for each of these temperatures. With these values, other optimum coats and corresponding drying temperatures could be approximated. With this

Test 12 cont.

After the data had been worked, and the remaining three days were
occupied with papers from an old set of photographs. From the results
obtained, it was found that a large amount of the sensitivity depends
upon three days were occupied in the investigation. In various tests and
with other data it was found.

Test 13.

The results from the first two tests were so different that it
was believed that by using other data it would be possible to
of cooling, it is sensitivity could be tested at a number of
regular sensitivity. With this in mind, several tests, 1200, 1300, and
1400 were run, with the following results: (1) The cooling
was used, and the effect of air cooling and oven cooling were compared.
For oven cooling, the oven was turned off, all vessels were closed, and
the oven was allowed to slowly cool to room temperature. The cooling
curve for this condition is shown in figure 11. Cooling in air, 1200
exposed so that no reading could be taken, but cooling in the oven, it
reached a sensitivity of 0.0005 in/in. It was interesting to note
that this temperature was the same as that of increasing the oven and number
of bubbles in the cooling. This can be seen in fig. 12. It is clearly
explained.

Test 14.

From the preceding tests, it was apparent that the cooling
temperature had a definite influence on the results. It was decided to
on the order of 0.0005 in/in. It was decided to select four temperatures
of 125, 130, 135, and 140, and to determine the cooling curve for
each of these temperatures. With these values, the cooling curve could
be determined by using temperatures could be determined. With this

TEST 14 cont.

In mind, 1201, 1202, 1203, and 1204 were used with 1207 being optimum. A drying temperature of 175 F was used and cooling was in the oven. Unfortunately, the oven control was faulty on this test, and the temperature rose to 195 F. Upon cooling in the oven, all coats crazed except 1201, and this coat crazed after being out of the oven for about 5 minutes. It was noted that the high temperature had formed a glaze on the surface of the lacquer giving it a glossy finish. There were very few bubbles except in the fairly thick parts of the coating. Also, the cracks which were formed by calibration were formed under this glossy coat and could not be dye etched. Dye etching under load had the same effect as dye etching an unstressed strip.

TEST 15.

Since Test 14 showed 1201 to be the best coat at 175 F, this coat was checked for dispersion. All twelve bars were prepared with 1201, and 1205 was the optimum. Ten of these were oven cooled to 8h F where it was found that six had crazed, and the remaining four were immediately removed and tested. It is to be noted that again the oven temperature rose above the setting, this time to 185 F, and also that the outside temperature was lower than for the previous test. The dispersion of the four specimens tested was very low, which is of course very desirable. The strain varied only from 0.00015 to 0.00016 in/in. Two of the bars were dried at room temperature, and the effect of the heat treatment can be seen from these results.

TEST 16.

Since only four values were obtained from Test 15, that run was repeated, and the oven carefully watched to insure that the 175 F temperature was not exceeded. None of the bars crazed, and some were

17

TEST 11 CONT.

in which, 1901, 1902, 1903, and 1904 were used with 1905 being optimum.
A drying temperature of 175° was used and cooling was in the oven.
Unfortunately, the oven control was faulty on days 1001 and 1002, and the temperature
rose to 192°. When cooling in the oven, all coats showed cracks 1001,
and this coat showed cracks after being out of the oven for about 2 minutes.
It was noted that the high temperature had led to a loss of the sand on
of the laguer giving it a glassy finish. There were very few defects
except in the early stages of the coating. After the coating
which were formed by condensation were removed under this glassy coat
and could not be removed. The coating which had the most effect
as the coating was removed.

TEST 12.

Since test 11 showed that the best coat was 1905, this
coat was checked for efficiency. All twelve coats were prepared and
1901, and 1904 was the optimum. Ten of these were used again in test 1.
There is no doubt that six was already the best material for use
immediately removed and tested. It is to be noted that again the
oven temperature rose above the limit, this time to 192° F, and this
time the oven temperature was 192° F for the twelve coats. The
discovery of the oven temperature being very low, and as of course
very variable. The results varied with time 1901 to 1905, 1901,
Two of the coats were used as from before, and the effect of the
best treatment can be seen from these results.

TEST 13.

Since only four values were obtained from test 12, and the
was repeated, and the oven carefully watched to ensure this was
repeated and the oven was checked and the results were as follows

TEST 16 cont.

out of the oven an hour. This indicates that with a final testing temperature of about 77 F, 1201 is at an optimum using a temperature of 175 F. Dispersion on this test was also very low, sensitivity ranging from 0.00015 to 0.00016.

TEST 17

The next series of tests were at 150 F. With 1207 as optimum, 1203, 1204, 1205, and 1206 were used. This test indicated that 1204 was the coat giving the highest sensitivity without crazing. 1206 and 1205 were highly crazed.

TEST 18

With the information from test 17, it was desirable to check 1204 for dispersion. As a corollary to this, the effect of the thickness of the coatings was roughly determined. One coat was sprayed especially thick, and one coat especially thin, the rest being of the desirable thickness. The thin coat gave a relatively low sensitivity, while the thick coat gave extremely high sensitivity of 0.00001 with no craze. One bar of medium thickness was given rough treatment by dropping and jarring, and little effect was noted. The appearance of these various bars can be seen on figure 11. The bars were taken from the oven at 60 F, and four bars were broken after being removed for 0, 5, 7, and 10 minutes. After 10 minutes, the bars began to craze. The remainder of the bars were broken immediately after being removed from the oven, and except for the special coats already mentioned, the dispersion ranged from 0.00017 to 0.0002. It was also observed that the thicker coats besides being more sensitive gave most rapid and greater amount

TEST 18 cont.

of crazing. From this test it is apparent that for tests under 10 minutes with room temperature of about 72 F and oven temperature of 150 F, 1204 is the best coat. For higher room temperature, 1203 will prove optimum.

TEST 19

The next series of tests were at 125 F. With 1206 as optimum, 1206, 1207, 1208, and 1209 were used. 1208 and 1209 were crazed after cooling in oven to 78 F. 1206 and 1207 gave high sensitivity, but crazed after sitting in cool room of 68 F. For higher testing temperature, 1206 would not craze.

TEST 20

With the information of test 19, it was decided to use 1206 and check for dispersion. Since the outside (room) temperature was so cool, the strips were calibrated immediately, and the sensitivity ranged from 0.00012 to 0.00020, which quantitatively is small variation, but is a high percentage dispersion, in the order of 40% to 50%.

TEST 21

This test was at 100 F, and coats 1207, 1208, 1209, and 1210 were used with 1205 as the optimum. 1209 and 1210 tended to craze, while 1207 and 1208 were satisfactory. It was strange to note that 1207 was more sensitive than 1208.

TEST 22

With the above information it was decided to check 1208 and

1957-1958

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TEST 22 cont.

1209 for dispersion, with 1205 as optimum, and drying temperature of 100 F. Upon cooling in the oven to 76 F, 1209 was all crazed, and two of 1208 indicated slight craze. The sensitivity of the 1208 ranged from 0.00016 to 0.00027 in/in, giving a dispersion of about 50%.

CREEP TESTS.

The technique of heat treatment brought up a new question, that of creep. The plastic property of the lacquer which causes the creep was discussed in the preceding section and will not be repeated here. The authors felt that the baking procedure would probably affect the creep of the coating both by hardening the coating and by increasing the sensitivity. It would seem that baking would reduce creep by reducing the plasticity of the lacquer. Since so little time was available the tests for creep after heating were not handled as well as they might have been. The tests were made in the calibration rig by loading the bar at varying rates and noting the time to reach full deflection. This was an unsatisfactory method, but time did not permit a more elaborate setup. The rate of loading was not constant as desired; times longer than 10 minutes were very difficult to obtain; and the test should have been pure tension rather than cantilever bending. However, a rough check of creep with optimum coat at 170 F, 150 F, and 125 F was all that was desired for this project, and a more thorough study is recommended in the future.

CREEP TEST 1-C

Twelve bars were prepared with coat #1201, dried in the oven at 170 F, and cooled in the oven to room temperature before testing.

1900 10 10

The following is a list of the names of the persons who have been elected to the office of Justice of the Peace for the year 1901. The names are given in alphabetical order of the surnames. The names of the persons who have been elected to the office of Justice of the Peace for the year 1901 are: [illegible]

1901 10 10

The following is a list of the names of the persons who have been elected to the office of Justice of the Peace for the year 1902. The names are given in alphabetical order of the surnames. The names of the persons who have been elected to the office of Justice of the Peace for the year 1902 are: [illegible]

1902 10 10

The following is a list of the names of the persons who have been elected to the office of Justice of the Peace for the year 1903. The names are given in alphabetical order of the surnames. The names of the persons who have been elected to the office of Justice of the Peace for the year 1903 are: [illegible]

CREEP TEST 1-C cont.

Tests were made at the following loading times, 0, 0, 0, 5, 13, 25, 40, 45, 70, 180, 270, 545 seconds. There was no creep. All values of strain recorded were within the normal dispersion range, and those at longer times were actually on the more sensitive side. Further tests should be made to check these results together with much slower rates of loading.

CREEP TEST 2-C

Twelve bars were prepared with coat #1203 and dried in the oven at 150 F, and cooled in the oven to room temperature before testing. Tests were made at the following times: 0, 0, 0, 5, 15, 60, 100, 200, 400, and 450 seconds. Again there was no creep. The specimens tested at 200 and 400 seconds had a sensitivity below 0.0001 in/in, but this was no doubt due to the fact that the coating was too thick. Two of the specimens tested at 0 seconds had a sensitivity of 0.00025 in/in, due to a very thin coating. This is another example of the effect of coat thickness on sensitivity.

CREEP TEST 3-C

Eleven bars were prepared with coat #1206. Eight were dried in the oven at 120 F, and cooled in the oven to room temperature before testing. Tests were made at the following times: 0, 0, 5, 30, 70, 150, 250, and 400 seconds. Again there was no creep.

Three bars were dried at room temperature and tested at the following times: 0, 0, and 70 seconds. The specimen did not crack in the 70 second loading test, since the sensitivity was greater than 0.0010 in/in. This illustrates the elimination of creep by heating.

100% and 100%.

Tests were run at the following loading times: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100 seconds. There was no change in values of strain recorded with strain gauge. The strain gauge was used at longer times. The strain gauge was sensitive to strain. The strain gauge should be used at a low rate of loading or at a low rate of strain rate of loading.

100% and 100%.

Tests were run at the following loading times: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100 seconds. There was no change in values of strain recorded with strain gauge. The strain gauge was used at longer times. The strain gauge was sensitive to strain. The strain gauge should be used at a low rate of loading or at a low rate of strain rate of loading.

100% and 100%.

Tests were run at the following loading times: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100 seconds. There was no change in values of strain recorded with strain gauge. The strain gauge was used at longer times. The strain gauge was sensitive to strain. The strain gauge should be used at a low rate of loading or at a low rate of strain rate of loading.

CONCLUSIONS

The authors cannot support the claim of the manufacturer for the sensitisation of brittle lacquer by dye etching under load. From the investigation reported herein, this claim seems extremely optimistic. On all tests, readings were taken before and after dye etching under load, and the sensitivity was never increased by the 0.0006 in/in promised. The normal increase was from 0.0002 to 0.0004 in/in, and this seemed to be of no value for a quantitative study. Figure 10 shows the effect of dye etching under load, and this is a slight indication of the difficulty of determining the critical strain which is so important in a quantitative analysis. This illustration shows the dye etched pattern when used with and without the heat treatment, and it can be seen that the cracks grade into preferred orientation of the craze which grades into random craze. This preferred orientation might be of some value in an analysis to locate the position of the strain pattern, but for any use much experience is required for the use of the dye etchant. After several weeks of constant use of this technique, the two authors would vary considerably in reading a strip, and when a third experienced party was called in, the difference was even greater. Thus from the results obtained in these tests, the authors cannot substantiate the claims of the manufacturer.

The results from the investigation of the possibilities of heat treatment were very encouraging, and this technique is believed to be of great practical use in the field of stress analysis. With the limited apparatus available to the authors, strains of the order of 0.00015 were measured consistently, drying craze was eliminated entirely, and creep with slow rates of loading was eliminated.

For the maximum sensitivity with heat treatments, the specimens

DISCUSSION

The authors would support the claim of the manufacturer for the sensitization of barbitol lactone by the standing under load. From the investigation reported herein, this claim seems extremely overstated. On all tests, readings were taken before and after the standing under load, and the sensitivity was never increased by the 0.0005 in/in increase. The maximum increase was from 0.0005 to 0.001 in/in, and this seemed to be of no value for a quantitative study. Figure 10 shows the effect of the standing under load, and this is a slight indication of the difficulty of determining the critical strain which is so important in a quantitative analysis. This 10 in/in increase shows the effect of the standing under load and without the heat treatment, and it can be seen that the critical strain is increased orientation of the strain which grades into random strain. This procedure orientation might be of some value in an analysis to locate the position of the strain, but for any such experiment is required for the use of the specimen. After several weeks of constant use of this technique, the authors would very considerably in reaching a strip, and when a third experienced party was called in, the difference was even greater. Thus the results obtained in these tests, the authors cannot recommend since the claims of the manufacturer.

The results from the investigation of the possibilities of heat treatment were very encouraging, and this seems to be believed to be of great practical use in the field of stress analysis. With the limited apparatus available to the authors, a strain of 0.001 in/in was measured consistently, giving error was eliminated entirely, and creep with slow rates of loading was eliminated.

For the maximum sensitivity with heat treatment, the specimens

must be cooled sufficiently after being removed from the oven. The cooling rate affects crazing and sensitivity, and it is regretted that available equipment allowed only two cooling rates, cooling in air and cooling in the oven (fig. 13). Cooling in the oven at the slower rate reduced crazing and increased sensitivity more than cooling at the faster rate.

For every coating there seems to be an optimum temperature for drying, or, in other words, for every oven temperature there is an optimum coating which gives the greatest sensitivity without crazing. The minimum value of strain that the authors were able to obtain with no crazing was from 0.00010 to 0.00015 in/in, and this sensitivity was obtained with several coatings by using different drying temperatures. For steel with a modulus of elasticity of 30,000,000, this value of strain corresponds to 3000 - 4500 p.s.i.

Time was not available for a complete study of dispersion and expected error, but from the tests made, the dispersion is greatly reduced by using a low numbered coating and drying at a high temperature. Using coating 1201 dried at 170 F and cooled in the oven, sixteen tests gave readings from 0.00015 to 0.00016. This is an error of only 300 p.s.i. when steel is used. With normal air drying methods giving sensitivity of 0.0008 in/in, the 15% error promised by the manufacturer means an error of 3600 p.s.i. when steel is used. This indicates that heat treatment also increases the accuracy of the results obtained by Stresscoat analysis, however, many more tests must be made to prove this large increase in accuracy.

Outside temperature and humidity conditions seem to have no effect on the coating during heat treatment. However, the temperature of the specimen at the time of the test is important. Sensitivity and crazing depend largely on the thickness of the coating. Heavy coats

are more sensitive and craze more quickly than light coats as seen in figure 11. The most satisfactory method of obtaining uniform thickness of coat at all times is to spray all specimens to the same color, a dark yellow. The lower numbered coats being thinner are more easily sprayed and control of thickness is much better than with higher numbers. Downhand spraying was found to be more satisfactory than horizontal for spraying the thinner coats which run excessively.

It might be well to note here that some old cans of Stresscoat were found to be much less sensitive than newer ones of the same number. This might have been due to evaporation or to some unknown additions to the can. However, it is felt that a warning to future users might be in order.

Another big advantage seems to have been found for the heat treatment - that of eliminating creep. A few very rough tests were made to get an idea of the effect of creep on baked specimens under slow application of load, and the results showed not a trace of creep with loading times up to ten minutes. This promises to be an easy solution to the problem of creep, and if further investigations can substantiate this theory, the process of heat treatment will gain added importance.

An investigation was conducted by A. S. Waters and D. K. Marquardt to determine the value of heat treatment on more complicated structures (10). The results which will not be produced here tend to confirm the results obtained by the investigation of the authors.

A summary of the advantages of heat treatment over other methods of sensitizing shows that: (1) Heat treatment seems to be the only method applicable to an investigation to determine the first crack in a structure being slowly loaded. (2) Heat treatment seems

to be the only method applicable to an investigation to determine a low strain from a lead which is quickly applied and removed. (3) Heat treatment is the only method offering control of sensitivity at low values of strain for a quantitative analysis. (4) Heat treatment is the only method found to eliminate creep and drying crasse.

The following is a table of drying temperatures for four grades of Stresscoat with testing temperature of 75 F:

#1201	170 F
#1203	150 F
#1206	125 F
#1208	100 F

The drying temperature may be slightly higher for higher testing temperature and lower for lower testing temperatures. Control of sensitivity may be had by varying the drying temperature for a given coat or by varying the coat for a given drying temperature. Coat #1201 at 170 F gave the least dispersion.

to be the only method available for an investigation of determining
a low critical from a low which is subject to high and low. (2)
The treatment is the only method of control of sensitivity
as low values of critical for a quantitative analysis. (3) (4)
Treatment is the only method of control of critical from a high
value.

The following is a table of critical for various for low
values of treatment with a critical temperature of 15 °C.

1500	1500
1500	1500
1500	1500
1500	1500

The critical temperature and the slightly higher for higher heating
temperature and lower for lower heating temperature. Control of
sensitivity and the low of heating the drying temperature for a given
cost or by varying the cost for a given drying temperature. Cost
of heating as 150 °C have low heating temperature.

RECOMMENDATIONS

The authors regret that more time was not available to continue this work to completion. The results obtained from this investigation which was so limited by time and equipment seem to indicate that a more thorough study with well controlled conditions of outside temperature and humidity, oven temperature and humidity, and cooling rate would be of great benefit to the field of stress analysis. It is recommended that further investigation be made to find the exact optimum baking temperature for each coat together with the dispersion for each and the optimum cooling rate to the testing temperature. The authors feel that a shorter drying time might be coupled with a much longer cooling time to give better results. The heat treatments should be further investigated on complicated shapes and on materials other than steel. A correction factor for applying to results obtained using a steel calibration strip in conjunction with a structure of some material having a different thermal coefficient of expansion would undoubtedly be of great value. Refrigeration after drying and before stressing the coating should be investigated (9), but at present this is limited to qualitative work only. Other ideas might be found in the publications listed in the bibliography.

The subject of the present paper is the study of the
 properties of the function $f(x)$ defined by the series

$$f(x) = \sum_{n=0}^{\infty} \frac{a_n}{n!} x^n$$
 where a_n is a sequence of real numbers. The function $f(x)$ is
 called an entire function if it is analytic in the whole
 complex plane. The function $f(x)$ is called a polynomial
 if it is a finite sum of powers of x . The function $f(x)$ is
 called a transcendental entire function if it is not a
 polynomial. The function $f(x)$ is called a meromorphic
 function if it is analytic in the whole complex plane
 except for a finite number of points where it has poles.
 The function $f(x)$ is called a holomorphic function if it
 is analytic in a domain. The function $f(x)$ is called a
 harmonic function if it is the real part of a holomorphic
 function. The function $f(x)$ is called a subharmonic
 function if it is less than or equal to the real part of a
 holomorphic function. The function $f(x)$ is called a
 superharmonic function if it is greater than or equal to
 the real part of a holomorphic function. The function $f(x)$
 is called a harmonic majorant if it is harmonic and
 greater than or equal to the real part of a holomorphic
 function. The function $f(x)$ is called a harmonic minorant
 if it is harmonic and less than or equal to the real part
 of a holomorphic function. The function $f(x)$ is called a
 harmonic conjugate if it is harmonic and its real part is
 the real part of a holomorphic function.

TEST I.

When sprayed: dry bulb - 74
wet bulb - 61

When stressed: dry bulb - 75
wet bulb - 61

Optimum coating - #1205

All specimens dried at room temperature 24 hours, stressed, and etched under load.

<u>Coat Number</u>	<u>Sensitivity Before Etch</u>	<u>Sensitivity After Etch</u>
1203	0.00122	0.00100
1203	.00118	.00090
1203	.00106	.00085
1205	.00080	.00050
1205	.00080	.00053
1205	.00080	.00050
1205	.00085	.00048
1205	.00080	.00051
1205	.00086	.00055
1207	.00078	.00040
1207	.00080	.00038
1207	.00075	.00040

REMARKS: Viewed through a magnifying glass under strong light, very faint craze marks oriented normal to the direction of principal stress were found in the etched specimens. The end of these marks was very difficult to distinguish, and the value of the sensitivity is quite arbitrary. The value of this etchant on complicated shapes seems questionable.

Test 1

When sprayed: dry bulb - 75
wet bulb - 61
When stressed: dry bulb - 72
wet bulb - 61

Optimum condition - 11:00

All specimens dried at room temperature 24 hours, stressed, and stored under load.

Coast Number	Sensitivity before load	Sensitivity after load
1201	0.0017	0.0010
1202	0.0018	0.0020
1203	0.0025	0.0022
1204	0.0030	0.0020
1205	0.0030	0.0022
1206	0.0030	0.0020
1207	0.0032	0.0018
1208	0.0030	0.0022
1209	0.0038	0.0022
1210	0.0035	0.0018
1211	0.0030	0.0022
1212	0.0032	0.0018
1213	0.0030	0.0022
1214	0.0032	0.0018
1215	0.0032	0.0018

REMARKS: Viewed through a magnifying glass in an ordinary light.
very faint cross marks oriented normal to a direction of strain.
stress was found in the strain direction. The most of these marks
the very difficult to distinguish, and the value of a sensitivity
is quite arbitrary. The value of this section is not listed because
some questionable.

TEST 2

When sprayed: dry bulb - 75
wet bulb - 61

When stressed: dry bulb - 77
wet bulb - 64

Optimum coating - #1205

All specimens dried at room temperature 24 hours, stressed, and etched under load.

<u>Coat Number</u>	<u>Sensitivity Before Etch</u>	<u>Sensitivity After Etch</u>
1205	0.00088	0.00047
1205	.00085	.00065
1205	.00085	.00045
1205	.00086	.00060
1205	.00105	.00065
1205	.00095	.00057
1207	.00080	.00065
1207	.00090	.00065
1207	.00075	.00040
1209	.00095	.00065
1209	.00055	.00030
1209	.00067	.00040

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 10 - died Jew

ALL economic aid to Cuba will be suspended until the Cuban government agrees to accept the principles of the Declaration of Havana.

Coast Number	Latitude North	Longitude West
1201	0.0000	0.0000
1202	0.0002	0.0002
1203	0.0004	0.0004
1204	0.0006	0.0006
1205	0.0008	0.0008
1206	0.0010	0.0010
1207	0.0012	0.0012
1208	0.0014	0.0014
1209	0.0016	0.0016
1210	0.0018	0.0018
1211	0.0020	0.0020
1212	0.0022	0.0022
1213	0.0024	0.0024
1214	0.0026	0.0026
1215	0.0028	0.0028

TEST 3

When sprayed: dry bulb - 77
wet bulb - 64

When stressed: dry bulb - 78
wet bulb - 65

Optimum coating - #1206

All specimens dried at room temperature 24 hours, stressed, and etched under load.

<u>Coat Number</u>	<u>Sensitivity Before Etch</u>	<u>Sensitivity After Etch</u>
1206	0.00085	0.00045
1206	.00090	.00040
1206	.00082	.00050
1206	.00105	.00055
1208	.00080	.00035
1208	.00082	.00033
1208	.00078	.00030
1211	.00070	.00040
1211	.00070	.00030
1211	.00080	.00040

Two specimens were sprayed with #1206 and dried in oven at 100°F for 24 hours. They were removed from oven and cooled in air for the times shown before stressing, and load etched.

<u>Time Cool In Air</u>	<u>Sensitivity Before Etch</u>	<u>Sensitivity After Etch</u>
1 min.	0.00085	0.00045
15 min.	.00045	.00025

REMARKS: Oven temperature during drying varied from 98°F to 103 F, and specimens were cooled in air by placing on table away from air currents. Etching time was decreased markedly.

55 - 1000 lbs. weight
56 - 1000 lbs. weight

57 - 1000 lbs. weight
58 - 1000 lbs. weight

Optimum coating - 1000

All specimens dried at room temperature in open air, and cooled

under load.

Test Number	Weight (lbs.)	Weight (lbs.)
1001	1000.0	1000.0
1002	1000.0	1000.0
1003	1000.0	1000.0
1004	1000.0	1000.0
1005	1000.0	1000.0
1006	1000.0	1000.0
1007	1000.0	1000.0
1008	1000.0	1000.0
1009	1000.0	1000.0
1010	1000.0	1000.0

Two specimens were tested at 1000 lbs. weight in open air, and cooled under load. The results are shown in the table below.

Test Number	Weight (lbs.)	Weight (lbs.)
1011	1000.0	1000.0
1012	1000.0	1000.0

Over 1000 specimens were tested at 1000 lbs. weight in open air, and cooled under load. The results are shown in the table below.

TEST 4

When sprayed: dry bulb - 78
wet bulb - 71

When stressed: dry bulb:- 78
wet bulb - 67

Optimum coating - #1206

The specimens dried at room temperature 24 hours, stressed, and etched under load.

<u>Coat Number</u>	<u>Sensitivity Before Etch</u>	<u>Sensitivity After Etch</u>
1206	0.00102	0.00075
1206	.00105	.00070

Ten specimens dried in oven at 100 F for 24 hours, cooled in air for the times indicated before testing, and etched under load. Coat #1206 was used throughout.

<u>Time Cool In Air</u>	<u>Sensitivity Before Etch</u>	<u>Sensitivity After Etch</u>
0 min.	0.00090	0.00050
0 min.	.00095	.00060
2 min.	.00072	.00050
4 min.	.00062	.00050
5 min.	.00080	.00060
6 min.	.00060	.00041
8 min.	.00060	.00040
10 min.	.00061	.00050
12 min.	.00055	.00035
14 min.	.00058	.00036

REMARKS: Curve of Sensitivity vs. Cooling Rate is fig. 3.

7 - 10 - 1971
11 - 10 - 1971

1. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ 2. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ 3. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

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CHICAGO, ILLINOIS 60637
U.S.A.

TEST 5

When sprayed: dry bulb - 78
wet bulb - 67

When stressed: Dry bulb - 78
Wet bulb - 71

Optimum coating - #1207

Specimens were dried in oven @ 100 F, air cooled for times shown before stressing, and etched under load.

<u>Coat Number</u>	<u>Time Cool in Air</u>	<u>Sensitivity Before Etch</u>	<u>Sensitivity After Etch</u>
1209	0 min.	0.00100	0.00055
1209	5 min.	.00060	.00040
1209	10 min.	.00055	.00025
1209	15 min.	.00035	Off scale
1207	0 min.	.00090	.00052
1207	10 min.	.00050	.00030
1207	20 min.	.00060	.00030
1207	30 min.	.00050	Off scale

Specimens were dried at room temperature, 24 hours, stressed and etched under load.

<u>Coat Number</u>	<u>Sensitivity Before Etch</u>	<u>Sensitivity After Etch</u>
1209	0.00075	0.00050
1209	.00090	.00090
1207	.00085	.00045
1207	.00085	.00070

When the value of the variable is 10, the value of the function is 100. When the value of the variable is 20, the value of the function is 400. When the value of the variable is 30, the value of the function is 900. When the value of the variable is 40, the value of the function is 1600. When the value of the variable is 50, the value of the function is 2500.

When the value of the variable is 10, the value of the function is 100.

When the value of the variable is 10, the value of the function is 100. When the value of the variable is 20, the value of the function is 400. When the value of the variable is 30, the value of the function is 900. When the value of the variable is 40, the value of the function is 1600. When the value of the variable is 50, the value of the function is 2500.

Variable	Function	Value	Cost
10	100	10	100
20	400	20	400
30	900	30	900
40	1600	40	1600
50	2500	50	2500

When the value of the variable is 10, the value of the function is 100. When the value of the variable is 20, the value of the function is 400. When the value of the variable is 30, the value of the function is 900. When the value of the variable is 40, the value of the function is 1600. When the value of the variable is 50, the value of the function is 2500.

Variable	Function	Value	Cost
10	100	10	100
20	400	20	400
30	900	30	900
40	1600	40	1600

TEST 6

When sprayed: dry bulb - 78
wet bulb - 71

When stressed: dry bulb - 77
wet bulb - 62

Optimum coating - #1208

All specimens were sprayed with coat 1208, then dried in oven at 100 F for 24 hours, and two were dried at room temperature for 24 hours. All were dye etched under load.

<u>Time Cool In Air</u>	<u>Sensitivity Before Etch</u>	<u>Sensitivity After Etch</u>
0 min.	0.00080	0.00060
3 min.	.00065	.00040
6 min.	.00050	.00040
9 min.	.00025	.00025
12 min.	.00035	.00030
15 min.	.00030	off scale
20 min.	.00020	.00020
25 min.	.00024	.00020
30 min.	.00020	.00018
40 min.	.00020	.00020
Air dried	.00080	.00045
Air dried	.00070	.00035

REMARKS: Readings lower than 0.0004 in/in were below scale and were extrapolated. Error is probably very high since small distance gives a large change in strain reading.

TEST 7

When sprayed: dry bulb - 74
wet bulb - 70

When stressed: dry bulb - 76
wet bulb - 66

Optimum coating - 1207

All specimens are coating 1209. Ten specimens were dried in oven at 100 F for 24 hours, cooled in still air for times indicated, stressed, and etched under load. Two specimens were dried at room temperature for 24 hours, stressed, and etched under load.

<u>Time Cool In Air</u>	<u>Sensitivity Before Etch</u>	<u>Sensitivity After Etch</u>
0 min.	0.00090	0.00052
3 min.	.00080	.00030
6 min.	.00050	.00018
9 min.	.00038	.00018
12 min.	.00036	.00015
15 min.	.00038	.00015
20 min.	.00023	.00015
25 min.	.00029	.00016
30 min.	.00022	.00014
40 min.	.00020	.00010
Air dried	.00100	.00067
Air dried	.00110	.00065

REMARKS: Curve of Sensitivity vs. Cooling Rate is fig.

TEST 7

When sprayed: dry bulb - 76
wet bulb - 66

When sprayed: dry bulb - 76
wet bulb - 70

Optimum cooling - 150°

All specimens are cooling 150°. Ten specimens were dried in oven at 100° for 24 hours, cooled in still air for times indicated, sprayed, and etched under load. Two specimens were dried at room temperature for 24 hours, sprayed, and etched under load.

<u>Time Cool in Air</u>	<u>Sensitivity before etch</u>	<u>Sensitivity after etch</u>
0 min.	0.00000	0.00000
2 min.	0.00000	0.00000
4 min.	0.00000	0.00000
6 min.	0.00000	0.00000
8 min.	0.00000	0.00000
10 min.	0.00000	0.00000
12 min.	0.00000	0.00000
14 min.	0.00000	0.00000
16 min.	0.00000	0.00000
18 min.	0.00000	0.00000
20 min.	0.00000	0.00000
22 min.	0.00000	0.00000
24 min.	0.00000	0.00000
26 min.	0.00000	0.00000
28 min.	0.00000	0.00000
30 min.	0.00000	0.00000
32 min.	0.00000	0.00000
34 min.	0.00000	0.00000
36 min.	0.00000	0.00000
38 min.	0.00000	0.00000
40 min.	0.00000	0.00000
42 min.	0.00000	0.00000
44 min.	0.00000	0.00000
46 min.	0.00000	0.00000
48 min.	0.00000	0.00000
50 min.	0.00000	0.00000
52 min.	0.00000	0.00000
54 min.	0.00000	0.00000
56 min.	0.00000	0.00000
58 min.	0.00000	0.00000
60 min.	0.00000	0.00000
62 min.	0.00000	0.00000
64 min.	0.00000	0.00000
66 min.	0.00000	0.00000
68 min.	0.00000	0.00000
70 min.	0.00000	0.00000
72 min.	0.00000	0.00000
74 min.	0.00000	0.00000
76 min.	0.00000	0.00000
78 min.	0.00000	0.00000
80 min.	0.00000	0.00000
82 min.	0.00000	0.00000
84 min.	0.00000	0.00000
86 min.	0.00000	0.00000
88 min.	0.00000	0.00000
90 min.	0.00000	0.00000
92 min.	0.00000	0.00000
94 min.	0.00000	0.00000
96 min.	0.00000	0.00000
98 min.	0.00000	0.00000
100 min.	0.00000	0.00000

REMARKS: Curves of sensitivity vs. cooling rate in fig.

TEST 8

When sprayed: dry bulb - 74
wet bulb - 66

When stressed: dry bulb - 74
wet bulb - 72

Optimum coating - #1206

All specimens were dried in oven at 120 F for 24 hours, cooled in still air for times indicated, stressed, and etched under load.

<u>Time Cool In Air</u>	<u>1208</u>	<u>1206</u>
20 min.	0.00017	0.00020
25 min.	.00017	.00022
30 min.	.00017	.00027
35 min.	.00018	.00025
40 min.	.00017	.00026
50 min.	.00017	.00020

REMARKS: The etchant showed no increase in sensitivity. Coating 1208 gives much less dispersion, but it crazed so that it is not recommended for use on complicated shapes.

TEST 9

When sprayed: dry bulb - 74
wet bulb - 72

When stressed: dry bulb - 78
wet bulb - 70

Optimum coating - #1208

All specimens were dried in oven at 90 F for 24 hours, cooled in still air for 20 min, and stressed.

1206
0.00073
.00075
.00067

1208
0.00057
.00060
.00058

1209
0.00055
.00060
.00062

1211
0.00048
.00047
.00047

Q TEST

10 - 1000 gals (beyond 1000)
10 - 1000 gals (beyond 1000)

10 - 1000 gals (beyond 1000)
10 - 1000 gals (beyond 1000)

1000 - 1000 gals (beyond 1000)

All specimens were dried in vacuum at 100°C for 48 hours, sealed in glass
air for 10 min and analyzed.

1000	1000
1000.0	1000.0
1000.0	1000.0
1000.0	1000.0
1000	1000
1000.0	1000.0
1000.0	1000.0
1000.0	1000.0

TEST 10

When sprayed: dry bulb - 78
wet bulb - 70

When stressed: dry bulb - 77
wet bulb - 67

Optimum coating - #1208

All specimens were dried in oven at 110 F for 24 hours, cooled in still air 20 minutes and stressed.

1206

0.00030

.00050

.00050

1208

0.00020

.00015

.00017

1209

0.00027

.00040

.00024

1211

C

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1. The first step is to identify the problem or question that needs to be answered.

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TEST 11

When sprayed: dry bulb - 77
 wet bulb - 67

When stressed: dry bulb 80
 wet bulb 68

Optimum coating - #1207

All specimens were dried in oven at 100 F for 24 hours, cooled in still air 20 minutes, and stressed.

1206

0.00048

.00042

.00040

1208

0.00038

.00038

.00037

1209

0.00028

.00028

.00030

1211

0.00025

.00027

.00022

of 70

10-11-12 13-14-15 16-17-18 19-20-21 22-23-24 25-26-27 28-29-30 31-32-33 34-35-36 37-38-39 40-41-42 43-44-45 46-47-48 49-50-51 52-53-54 55-56-57 58-59-60 61-62-63 64-65-66 67-68-69 70-71-72 73-74-75 76-77-78 79-80-81 82-83-84 85-86-87 88-89-90 91-92-93 94-95-96 97-98-99 100-101-102 103-104-105 106-107-108 109-110-111 112-113-114 115-116-117 118-119-120 121-122-123 124-125-126 127-128-129 130-131-132 133-134-135 136-137-138 139-140-141 142-143-144 145-146-147 148-149-150 151-152-153 154-155-156 157-158-159 160-161-162 163-164-165 166-167-168 169-170-171 172-173-174 175-176-177 178-179-180 181-182-183 184-185-186 187-188-189 190-191-192 193-194-195 196-197-198 199-200-201 202-203-204 205-206-207 208-209-210 211-212-213 214-215-216 217-218-219 220-221-222 223-224-225 226-227-228 229-230-231 232-233-234 235-236-237 238-239-240 241-242-243 244-245-246 247-248-249 250-251-252 253-254-255 256-257-258 259-260-261 262-263-264 265-266-267 268-269-270 271-272-273 274-275-276 277-278-279 280-281-282 283-284-285 286-287-288 289-290-291 292-293-294 295-296-297 298-299-300 301-302-303 304-305-306 307-308-309 310-311-312 313-314-315 316-317-318 319-320-321 322-323-324 325-326-327 328-329-330 331-332-333 334-335-336 337-338-339 340-341-342 343-344-345 346-347-348 349-350-351 352-353-354 355-356-357 358-359-360 361-362-363 364-365-366 367-368-369 370-371-372 373-374-375 376-377-378 379-380-381 382-383-384 385-386-387 388-389-390 391-392-393 394-395-396 397-398-399 400-401-402 403-404-405 406-407-408 409-410-411 412-413-414 415-416-417 418-419-420 421-422-423 424-425-426 427-428-429 430-431-432 433-434-435 436-437-438 439-440-441 442-443-444 445-446-447 448-449-450 451-452-453 454-455-456 457-458-459 460-461-462 463-464-465 466-467-468 469-470-471 472-473-474 475-476-477 478-479-480 481-482-483 484-485-486 487-488-489 490-491-492 493-494-495 496-497-498 499-500-501 502-503-504 505-506-507 508-509-510 511-512-513 514-515-516 517-518-519 520-521-522 523-524-525 526-527-528 529-530-531 532-533-534 535-536-537 538-539-540 541-542-543 544-545-546 547-548-549 550-551-552 553-554-555 556-557-558 559-560-561 562-563-564 565-566-567 568-569-570 571-572-573 574-575-576 577-578-579 580-581-582 583-584-585 586-587-588 589-590-591 592-593-594 595-596-597 598-599-600 601-602-603 604-605-606 607-608-609 610-611-612 613-614-615 616-617-618 619-620-621 622-623-624 625-626-627 628-629-630 631-632-633 634-635-636 637-638-639 640-641-642 643-644-645 646-647-648 649-650-651 652-653-654 655-656-657 658-659-660 661-662-663 664-665-666 667-668-669 670-671-672 673-674-675 676-677-678 679-680-681 682-683-684 685-686-687 688-689-690 691-692-693 694-695-696 697-698-699 700-701-702 703-704-705 706-707-708 709-710-711 712-713-714 715-716-717 718-719-720 721-722-723 724-725-726 727-728-729 730-731-732 733-734-735 736-737-738 739-740-741 742-743-744 745-746-747 748-749-750 751-752-753 754-755-756 757-758-759 760-761-762 763-764-765 766-767-768 769-770-771 772-773-774 775-776-777 778-779-780 781-782-783 784-785-786 787-788-789 790-791-792 793-794-795 796-797-798 799-800-801 802-803-804 805-806-807 808-809-810 811-812-813 814-815-816 817-818-819 820-821-822 823-824-825 826-827-828 829-830-831 832-833-834 835-836-837 838-839-840 841-842-843 844-845-846 847-848-849 850-851-852 853-854-855 856-857-858 859-860-861 862-863-864 865-866-867 868-869-870 871-872-873 874-875-876 877-878-879 880-881-882 883-884-885 886-887-888 889-890-891 892-893-894 895-896-897 898-899-900 901-902-903 904-905-906 907-908-909 910-911-912 913-914-915 916-917-918 919-920-921 922-923-924 925-926-927 928-929-930 931-932-933 934-935-936 937-938-939 940-941-942 943-944-945 946-947-948 949-950-951 952-953-954 955-956-957 958-959-960 961-962-963 964-965-966 967-968-969 970-971-972 973-974-975 976-977-978 979-980-981 982-983-984 985-986-987 988-989-990 991-992-993 994-995-996 997-998-999 1000-1001-1002 1003-1004-1005 1006-1007-1008 1009-1010-1011 1012-1013-1014 1015-1016-1017 1018-1019-1020 1021-1022-1023 1024-1025-1026 1027-1028-1029 1030-1031-1032 1033-1034-1035 1036-1037-1038 1039-1040-1041 1042-1043-1044 1045-1046-1047 1048-1049-1050 1051-1052-1053 1054-1055-1056 1057-1058-1059 1060-1061-1062 1063-1064-1065 1066-1067-1068 1069-1070-1071 1072-1073-1074 1075-1076-1077 1078-1079-1080 1081-1082-1083 1084-1085-1086 1087-1088-1089 1090-1091-1092 1093-1094-1095 1096-1097-1098 1099-1100-1101 1102-1103-1104 1105-1106-1107 1108-1109-1110 1111-1112-1113 1114-1115-1116 1117-1118-1119 1120-1121-1122 1123-1124-1125 1126-1127-1128 1129-1130-1131 1132-1133-1134 1135-1136-1137 1138-1139-1140 1141-1142-1143 1144-1145-1146 1147-1148-1149 1150-1151-1152 1153-1154-1155 1156-1157-1158 1159-1160-1161 1162-1163-1164 1165-1166-1167 1168-1169-1170 1171-1172-1173 1174-1175-1176 1177-1178-1179 1180-1181-1182 1183-1184-1185 1186-1187-1188 1189-1190-1191 1192-1193-1194 1195-1196-1197 1198-1199-1200 1201-1202-1203 1204-1205-1206 1207-1208-1209 1210-1211-1212 1213-1214-1215 1216-1217-1218 1219-1220-1221 1222-1223-1224 1225-1226-1227 1228-1229-1230 1231-1232-1233 1234-1235-1236 1237-1238-1239 1240-1241-1242 1243-1244-1245 1246-1247-1248 1249-1250-1251 1252-1253-1254 1255-1256-1257 1258-1259-1260 1261-1262-1263 1264-1265-1266 1267-1268-1269 1270-1271-1272 1273-1274-1275 1276-1277-1278 1279-1280-1281 1282-1283-1284 1285-1286-1287 1288-1289-1290 1291-1292-1293 1294-1295-1296 1297-1298-1299 1300-1301-1302 1303-1304-1305 1306-1307-1308 1309-1310-1311 1312-1313-1314 1315-1316-1317 1318-1319-1320 1321-1322-1323 1324-1325-1326 1327-1328-1329 1330-1331-1332 1333-1334-1335 1336-1337-1338 1339-1340-1341 1342-1343-1344 1345-1346-1347 1348-1349-1350 1351-1352-1353 1354-1355-1356 1357-1358-1359 1360-1361-1362 1363-1364-1365 1366-1367-1368 1369-1370-1371 1372-1373-1374 1375-1376-1377 1378-1379-1380 1381-1382-1383 1384-1385-1386 1387-1388-1389 1390-1391-1392 1393-1394-1395 1396-1397-1398 1399-1400-1401 1402-1403-1404 1405-1406-1407 1408-1409-1410 1411-1412-1413 1414-1415-1416 1417-1418-1419 1420-1421-1422 1423-1424-1425 1426-1427-1428 1429-1430-1431 1432-1433-1434 1435-1436-1437 1438-1439-1440 1441-1442-1443 1444-1445-1446 1447-1448-1449 1450-1451-1452 1453-1454-1455 1456-1457-1458 1459-1460-1461 1462-1463-1464 1465-1466-1467 1468-1469-1470 1471-1472-1473 1474-1475-1476 1477-1478-1479 1480-1481-1482 1483-1484-1485 1486-1487-1488 1489-1490-1491 1492-1493-1494 1495-1496-1497 1498-1499-1500 1501-1502-1503 1504-1505-1506 1507-1508-1509 1510-1511-1512 1513-1514-1515 1516-1517-1518 1519-1520-1521 1522-1523-1524 1525-1526-1527 1528-1529-1530 1531-1532-1533 1534-1535-1536 1537-1538-1539 1540-1541-1542 1543-1544-1545 1546-1547-1548 1549-1550-1551 1552-1553-1554 1555-1556-1557 1558-1559-1560 1561-1562-1563 1564-1565-1566 1567-1568-1569 1570-1571-1572 1573-1574-1575 1576-1577-1578 1579-1580-1581 1582-1583-1584 1585-1586-1587 1588-1589-1590 1591-1592-1593 1594-1595-1596 1597-1598-1599 1600-1601-1602 1603-1604-1605 1606-1607-1608 1609-1610-1611 1612-1613-1614 1615-1616-1617 1618-1619-1620 1621-1622-1623 1624-1625-1626 1627-1628-1629 1630-1631-1632 1633-1634-1635 1636-1637-1638 1639-1640-1641 1642-1643-1644 1645-1646-1647 1648-1649-1650 1651-1652-1653 1654-1655-1656 1657-1658-1659 1660-1661-1662 1663-1664-1665 1666-1667-1668 1669-1670-1671 1672-1673-1674 1675-1676-1677 1678-1679-1680 1681-1682-1683 1684-1685-1686 1687-1688-1689 1690-1691-1692 1693-1694-1695 1696-1697-1698 1699-1700-1701 1702-1703-1704 1705-1706-1707 1708-1709-1710 1711-1712-1713 1714-1715-1716 1717-1718-1719 1720-1721-1722 1723-1724-1725 1726-1727-1728 1729-1730-1731 1732-1733-1734 1735-1736-1737 1738-1739-1740 1741-1742-1743 1744-1745-1746 1747-1748-1749 1750-1751-1752 1753-1754-1755 1756-1757-1758 1759-1760-1761 1762-1763-1764 1765-1766-1767 1768-1769-1770 1771-1772-1773 1774-1775-1776 1777-1778-1779 1780-1781-1782 1783-1784-1785 1786-1787-1788 1789-1790-1791 1792-1793-1794 1795-1796-1797 1798-1799-1800 1801-1802-1803 1804-1805-1806 1807-1808-1809 1810-1811-1812 1813-1814-1815 1816-1817-1818 1819-1820-1821 1822-1823-1824 1825-1826-1827 1828-1829-1830 1831-1832-1833 1834-1835-1836 1837-1838-1839 1840-1841-1842 1843-1844-1845 1846-1847-1848 1849-1850-1851 1852-1853-1854 1855-1856-1857 1858-1859-1860 1861-1862-1863 1864-1865-1866 1867-1868-1869 1870-1871-1872 1873-1874-1875 1876-1877-1878 1879-1880-1881 1882-1883-1884 1885-1886-1887 1888-1889-1890 1891-1892-1893 1894-1895-1896 1897-1898-1899 1900-1901-1902 1903-1904-1905 1906-1907-1908 1909-1910-1911 1912-1913-1914 1915-1916-1917 1918-1919-1920 1921-1922-1923 1924-1925-1926 1927-1928-1929 1930-1931-1932 1933-1934-1935 1936-1937-1938 1939-1940-1941 1942-1943-1944 1945-1946-1947 1948-1949-1950 1951-1952-1953 1954-1955-1956 1957-1958-1959 1960-1961-1962 1963-1964-1965 1966-1967-1968 1969-1970-1971 1972-1973-1974 1975-1976-1977 1978-1979-1980 1981-1982-1983 1984-1985-1986 1987-1988-1989 1990-1991-1992 1993-1994-1995 1996-1997-1998 1999-2000-2001 2002-2003-2004 2005-2006-2007 2008-2009-2010 2011-2012-2013 2014-2015-2016 2017-2018-2019 2020-2021-2022 2023-2024-2025 2026-2027-2028 2029-2030-2031 2032-2033-2034 2035-2036-2037 2038-2039-2040 2041-2042-2043 2044-2045-2046 2047-2048-2049 2050-2051-2052 2053-2054-2055 2056-2057-2058 2059-2060-2061 2062-2063-2064 2065-2066-2067 2068-2069-2070 2071-2072-2073 2074-2075-2076 2077-2078-2079 2080-2081-2082 2083-2084-2085 2086-2087-2088 2089-2090-2091 2092-2093-2094 2095-2096-2097 2098-2099-2100 2101-2102-2103 2104-2105-2106 2107-2108-2109 2110-2111-2112 2113-2114-2115 2116-2117-2118 2119-2120-2121 2122-2123-2124 2125-2126-2127 2128-2129-2130 2131-2132-2133 2134-2135-2136 2137-2138-2139 2140-2141-2142 2143-2144-2145 2146-2147-2148 2149-2150-2151 2152-2153-2154 2155-2156-2157 2158-2159-2160 2161-2162-2163 2164-2165-2166 2167-2168-2169 2170-2171-2172 2173-2174-2175 2176-2177-2178 2179-2180-2181 2182-2183-2184 2185-2186-2187 2188-2189-2190 2191-2192-2193 2194-2195-2196 2197-2198-2199 2200-2201-2202 2203-2204-2205 2206-2207-2208 2209-2210-2211 2212-2213-2214 2215-2216-2217 2218-2219-2220 2221-2222-2223 2224-2225-2226 2227-2228-2229 2230-2231-2232 2233-2234-2235 2236-2237-2238 2239-2240-2241 2242-2243-2244 2245-2246-2247 2248-2249-2250 2251-2252-2253 2254-2255-2256 2257-2258-2259 2260-2261-2262 2263-2264-2265 2266-2267-2268 2269-2270-2271 2272-2273-2274 2275-2276-2277 2278-2279-2280 2281-2282-2283 2284-2285-2286 2287-2288-2289 2290-2291-2292 2293-2294-2295 2296-2297-2298 2299-2300-2301 2302-2303-2304 2305-2306-2307 2308-2309-2310 2311-2312-2313 2314-2315-2316 2317-2318-2319 2320-2321-2322 2323-2324-2325 2326-2327-2328 2329-2330-2331 2332-2333-2334 2335-2336-2337 2338-2339-2340 2341-2342-2343 2344-2345-2346 2347-2348-2349 2350-2351-2352 2353-2354-2355 2356-2357-2358 2359-2360-2361 2362-2363-2364 2365-2366-2367 2368-2369-2370 2371-2372-2373 2374-2375-2376 2377-2378-2379 2380-2381-2382 2383-2384-2385 2386-2387-2388 2389-2390-2391 2392-2393-2394 2395-2396-2397 2398-2399-2400 2401-2402-2403 2404-2405-2406 2407-2408-2409 2410-2411-2412 2413-2414-2415 2416-2417-2418 2419-2420-2421 2422-2423-2424 2425-2426-2427 2428-2429-2430 2431-2432-2433 2434-2435-2436 2437-2438-2439 2440-2441-2442 2443-2444-2445 2446-2447-2448 2449-2450-2451 2452-2453-2454 2455-2456-2457 2458-2459-2460 2461-2462-2463 2464-2465-2466 2467-2468-2469 2470-2471-2472 2473-2474-2475 2476-2477-2478 2479-2480-2481 2482-2483-2484 2485-2486-2487 2488-2489-2490 2491-2492-2493 2494-2495-2496 2497-2498-2499 2500-2501-2502 2503-2504-2505 2506-2507-2508 2509-2510-2511 2512-2513-2514 2515-2516-2517 2518-2519-2520 2521-2522-2523 2524-2525-2526 2527-2528-2529 2530-2531-2532 2533-2534-2535 2536-2537-2538 2539-2540-2541 2542-2543-2544 2545-2546-2547 2548-2549-2550 2551-2552-2553 2554-2555-2556 2557-2558-2559 2560-2561-2562 2563-2564-2565 2566-2567-2568 2569-2570-2571 2572-2573-2574 2575-2576-2577 2578-2579-2580 2581-2582-2583 2584-2585-2586 2587-2588-2589 2590-2591-2592 2593-2594-2595 2596-2597-2598 2599-2600-2601 2602-2603-2604 2605-2606-2607 2608-2609-2610 2611-2612-2613 2614-2615-2616 2617-2618-2619 2620-2621-2622 2623-2624-2625 2626-2627-2628 2629-2630-2631 2632-2633-2634 2635-2636-2637 2638-2639-2640 2641-2642-2643 2644-2645-2646 2647-2648-2649 2650-2651-2652 2653-2654-2655 2656-2657-2658 2659-2660-2661 2662-2663-2664 2665-2666-2667 2668-2669-2670 2671-2672-2673 2674-2675-2676 2677-2678-2679 2680-2681-2682 268

TEST 12

When sprayed: Dry bulb - 80
Wet bulb - 68

When stressed: Dry bulb - 79
Wet bulb - 67

Optimum coating - #1208

<u>Time cool In Air</u>	<u>Sensitivity</u>
5 min.	0.00045
7 min.	.00042
10 min.	.00035
12 min.	.00035
15 min.	.00030
20 min.	.00025
20 min.	.00030
30 min.	.00028
40 min.	.00045
50 min.	.00045
60 min.	.00048
Air dried	.00065

REMARKS: Samples tested at 40, 50, and 60 minutes were sprayed with lacquer from an old can of Stresscoat. This apparently had a definite effect on the sensitivity. Curve of Sensitivity vs. Cooling time is figure 4.

29 - 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

$\alpha_1 = 1.25 \sqrt{2} \approx 1.77$ $\alpha_2 = 1.25 \sqrt{2} \approx 1.77$
 $\alpha_3 = 1.25 \sqrt{2} \approx 1.77$ $\alpha_4 = 1.25 \sqrt{2} \approx 1.77$

1911 - 1912

Page No.	Date	Time
1	10/10/20	10:00 AM
2	10/10/20	10:00 AM
3	10/10/20	10:00 AM
4	10/10/20	10:00 AM
5	10/10/20	10:00 AM
6	10/10/20	10:00 AM
7	10/10/20	10:00 AM
8	10/10/20	10:00 AM
9	10/10/20	10:00 AM
10	10/10/20	10:00 AM
11	10/10/20	10:00 AM
12	10/10/20	10:00 AM
13	10/10/20	10:00 AM
14	10/10/20	10:00 AM
15	10/10/20	10:00 AM
16	10/10/20	10:00 AM
17	10/10/20	10:00 AM
18	10/10/20	10:00 AM
19	10/10/20	10:00 AM
20	10/10/20	10:00 AM

There is no doubt that the above information is correct and that the same is being furnished to the proper authorities for their consideration.

TEST 13

When Sprayed: dry bulb - 79
wet bulb - 67

When Stressed: Dry bulb - 78
wet bulb - 65

Optimum coating - #1207

All specimens were dried in oven at 150 F. Six were removed, cooled in still air for 25 minutes and stressed.

<u>Coat Number</u>	<u>Sensitivity</u>
1201	0.00030
1201	.00030
1203	.00030
1205	Crazed
1205	Crazed
1207	Crazed

Six were cooled in oven to 80 F and stressed.

1201	0.00030
1203	.00020
1203	.00019
1205	.00015
1207	Crazed
1207	Crazed

REMARKS: To cool in oven, oven was turned off and closed up. After about 2 hours the temperature had dropped to 80 F, and specimens were tested.

27 - 0100 Y20 .504190 1000
28 - 0100 Y20 .504190 1000

TO: - [illegible]

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DATE 08-10-2010 BY 60322 UCBAW

TO BY IS LABEL	RECEIVED 1960
02000.0	1051
02000.	1051
02000.	1051
02000	1051
02000	1051
02000	1051
02000	1051

.because box 4 00 of none in Nelson view x10

02000.0	1000
03000.0	1000
04000.0	1000
05000.0	1000
06000.0	1000
07000.0	1000
08000.0	1000
09000.0	1000

[illegible]

TEST 14

When sprayed: dry bulb - 79
wet bulb - 66

When stressed: dry bulb - 77
wet bulb - 65

Optimum coating - #1207

All specimens were dried at 175 F, cooled in oven, and stressed.

1201
0.00023

.00025

.00022

1202
0.00020

craze

craze

1203

C
R
A
Z
E

1204

C
R
A
Z
E

REMARKS: Oven temperature rose to 195 F during the night. All coats had a glazed finish with very few bubbles. Cracks formed under the surface, and etching had no effect on the strain pattern. Coat 1201 also crazed after setting at room temperature for about 5 minutes.

TEST 15

When sprayed: dry bulb - 72
wet bulb - 63

When stressed: dry bulb - 73
wet bulb - 63

Optimum coating - #1205

All specimens were prepared with coat 1201, dried in oven at 175 F, cooled in oven, and stressed.

<u>Number</u>	<u>Sensitivity</u>
1	0.00016
2	.00016
3	.00015
4	.00015
6 to 10	All crazed

Two specimens of coat 1201 were dried at room temperature.

<u>Number</u>	<u>Sensitivity</u>
1	0.00102
2	.00098

REMARKS: Six of the samples crazed in the oven when the temperature reached 84 F. The other four were removed and broken immediately. Again the oven temperature climbed above the setting, this time to 185 F, and again the glossy coat was formed on all bars.

TEST 12

55 - 1000 gms
56 - 1000 gms

57 - 1000 gms
58 - 1000 gms

59 - 1000 gms

All specimens were prepared with care and sealed in glass bottles, and returned.

Quantity	Weight
1000.0	1
1000.0	2
1000.0	3
1000.0	4
1000.0	5

The specimens of each of the five types are:

Quantity	Weight
1000.0	1
1000.0	2

Notes: The specimens of each of the five types are prepared with care and sealed in glass bottles, and returned. The specimens of each of the five types are prepared with care and sealed in glass bottles, and returned.

TEST 16

When sprayed: dry bulb - 72
wet bulb - 64

When spressed: dry bulb - 74
wet bulb - 65

Optimum coating - #1205

All specimens were prepared with coat 1201, dried in oven at 175 F,
cooled in oven, and stressed.

<u>Number</u>	<u>Sensitivity</u>
1	0.00015
2	.00015
3	.00015
4	.00015
5	.00015
6	.00015
7	.00015
8	.00016
9	.00016
10	.00016
11	.00016
12	.00016

REMARKS: The same glossy coat was obtained as in Tests 14 and 15.

10 - 1000
 10 - 1000
 10 - 1000

10 - 1000
 10 - 1000
 10 - 1000

1000 - 1000

All specimens were taken from the same locality. The specimens were collected in 1950.

Number	Specimen
1	1000
2	1000
3	1000
4	1000
5	1000
6	1000
7	1000
8	1000
9	1000
10	1000
11	1000
12	1000
13	1000

The specimens were taken from the same locality. The specimens were collected in 1950.

TEST 17

When sprayed: dry bulb - 77
wet bulb - 65

When stressed: dry bulb - 74
wet bulb - 65

Optimum coating - #1207

All specimens were dried in oven at 150 F, cooled in oven, and stressed.

1203

0.00022

.00020

.00022

1204

0.00019

.00018

.00020

1205

C

R

A

Z

E

1206

C

R

A

Z

E

TABLE IV

When sprayed: dry bulb - 77
wet bulb - 63

When sprayed: dry bulb - 77
wet bulb - 63

Optimum humidity - 100%

All specimens were dried in oven at 100°C until constant weight was reached.

1501
0.0000
0.0000
0.0000

1501
0.0000
0.0000
0.0000

1501
0
0
0
0
0

1501
0
0
0
0
0

TEST 18

When sprayed: dry bulb - 74
wet bulb - 65

When stressed: dry bulb - 72
wet bulb - 64

Optimum coating - #1205

All specimens were prepared with coat 1204, dried in oven at 150 F, cooled in oven, and stressed.

<u>Number</u>	<u>Sensitivity</u>
1	0.00018
2	.00018
3	.00018
4	.00015
5	.00018
6	.00021
7	.00017
8	.00018
9	.00021
10	.00010

REMARKS: Coatings began to show some crazing after about 15 minutes after removal from oven. Specimen 9 is the thin coat shown in figure 11, and specimen 10 is the thick coat shown in the same photograph. One specimen was handled roughly for 20 minutes. It crazed slightly, but did not have the reading. The sensitivity was 0.00017, and the photograph is figure 11.

TEST 19

When sprayed: dry bulb - 72
wet bulb - 64

When stressed: dry bulb - 70
wet bulb - 63

Optimum coating - 1206

All specimens were dried in oven at 125 F, cooled in oven, and stressed.

1206
0.00015
.00015
.00015

1207
0.00018
.00015
.00018

1208
C
R
A
Z
E

1209
C
R
A
Z
E

REMARKS: All crazed after sitting in cool room for about 15 minutes.

$$\frac{1}{2} = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

$$\frac{1}{2} = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

1/2 = 1/2 x 1/2 = 1/4

1/2 = 1/2 x 1/2 = 1/4

$$\frac{1}{2} = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

$$\frac{1}{2} = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

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$$\frac{1}{2} = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

$$\frac{1}{2} = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

$$\frac{1}{2} = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

$$\frac{1}{2} = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

1/2 = 1/2 x 1/2 = 1/4

TEST 20

When sprayed: dry bulb - 70
wet bulb - 63

When stressed: dry bulb - 71
wet bulb - 63

Optimum coating - #1205

All specimens were prepared with coat 1206, dried in oven at 125 F,
cooled in oven, and stressed.

<u>Number</u>	<u>Sensitivity</u>
1	0.00012
2	.00012
3	.00015
4	.00015
5	.00016
6	.00017
7	.00017
8	.00017
9	.00017
10	.00018
11	.00019
12	.00020

17 - 1000 1000 1000 1000
18 - 1000 1000 1000 1000

19 - 1000 1000 1000 1000
20 - 1000 1000 1000 1000

21 - 1000 1000 1000 1000

22 - 1000 1000 1000 1000
23 - 1000 1000 1000 1000

<u>Year</u>	<u>Value</u>
1980	1
1981	2
1982	3
1983	4
1984	5
1985	6
1986	7
1987	8
1988	9
1989	10
1990	11
1991	12

TEST 21

When sprayed: dry bulb - 71
wet bulb - 63

When stressed: dry bulb - 72
wet bulb - 63

Optimum coating - #1205

<u>Coat Number</u>	<u>Remarks</u>	<u>Sensitivity</u>
1207	Air cooled from 95 F	0.00021
1207	Air cooled from 88 F	0.00019
1207	Air cooled from 80 F	0.00018
1208	Air cooled from 95 F	0.00021
1208	Air cooled from 88 F	0.00020
1208	Air cooled from 80 F	0.00020
1209	Air cooled from 95 F	Grazed
1209	Stressed at 90 F	0.00020
1209	Stressed at 80 F	0.00015
1210	Air cooled from 95 F	Grazed
1210	Stressed at 90 F	0.00030
1210	Stressed at 80 F	0.00017

All specimens were dried in oven at 100 F, cooled in oven to temperatures shown and stressed or air cooled to room temperature and stressed as noted.

IT - client and server
 CC - client and server

USA - Mexico - Canada

DATE	DESCRIPTION	AMOUNT
1900.0	1000.00	1000.00
2100.0	1000.00	1000.00
3100.0	1000.00	1000.00
4100.0	1000.00	1000.00
5100.0	1000.00	1000.00
6100.0	1000.00	1000.00
7100.0	1000.00	1000.00
8100.0	1000.00	1000.00
9100.0	1000.00	1000.00
10100.0	1000.00	1000.00
11100.0	1000.00	1000.00
12100.0	1000.00	1000.00
13100.0	1000.00	1000.00
14100.0	1000.00	1000.00
15100.0	1000.00	1000.00
16100.0	1000.00	1000.00
17100.0	1000.00	1000.00
18100.0	1000.00	1000.00
19100.0	1000.00	1000.00
20100.0	1000.00	1000.00

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TEST 22

When sprayed: dry bulb - 72
wet bulb - 63

When stressed: dry bulb - 72
wet bulb - 64

Optimum coating - 1205

All specimens were dried in oven at 100 F, cooled in oven, and stressed.

1208
0.00016
.00025
.00022
.00027
.00021
.00019

1209
A
L
L
C
R
A
Z
E
D

REMARKS: It is believed that coat 1209 crazed because of the low testing temperature because in previous tests it was all right.

[illegible]

1960-1961

2008.05

CREEP TEST 1

All specimens were prepared with coat 1201, dried at 170 F, cooled in oven to room temperature, and loaded in the times indicated.

<u>Time of Loading</u>	<u>Sensitivity</u>
0 min.	0.00015
0 min.	.00015
0 min.	.00017
5 sec.	.00015
13 sec.	.00017
25 sec.	.00017
40 sec.	.00014
45 sec.	.00013
70 sec.	.00013
180 sec.	.00016
270 sec.	.00014
540 sec.	.00013

[illegible]

CRASP TEST 2

All specimens were prepared with coat 1203, dried at 150 F, cooled in oven to room temperature, and loaded in times indicated.

<u>Time of Loading</u>	<u>Sensitivity</u>
0 sec.	0.00020
5 sec.	.00014
15 sec.	.00014
15 sec.	.00016
60 sec.	.00015
100 sec.	.00020
200 sec.	.00010
400 sec.	.00013
450 sec.	.00010

REMARKS: Specimens for run of 200 seconds and 450 seconds were very thick coats. This accounts for the low strain reading.

TABLE 2

All specimens were prepared with care, dried at 120 °C, sealed in glass to avoid contamination, and loaded in glass containers.

Time of loading	Temperature
0 sec.	0.0000
2 sec.	0.0010
12 sec.	0.0015
12 sec.	0.0015
50 sec.	0.0015
100 sec.	0.0015
200 sec.	0.0015
400 sec.	0.0015
800 sec.	0.0015

REMARKS: Specimens for run of 200 seconds and 400 seconds were very thin plates. This accounts for the low strain readings.

CREEP TEST 3

All specimens were prepared with coat 1206, dried at 125 F, cooled in oven to room temperature, and loaded in times indicated.

<u>Time of Loading</u>	<u>Sensitivity</u>
0 sec.	0.00030
0 sec.	.00032
5 sec.	.00030
30 sec.	.00040
70 sec.	.00023
150 sec.	.00040
250 sec.	.00031
400 sec.	.00040

Three specimens were dried at room temperature and loaded in times indicated.

0 sec.	.00075
0 sec.	.00070
70 sec.	no crack at .00100

CHARTER

All specimens were prepared with care and in accordance with the instructions of the Bureau of the Census.

Specimen No.	Weight (gms.)
100-1	100.0
100-2	100.0
100-3	100.0
100-4	100.0
100-5	100.0
100-6	100.0
100-7	100.0
100-8	100.0
100-9	100.0
100-10	100.0

These specimens were prepared with care and in accordance with the instructions of the Bureau of the Census.

CHARTER

Specimen No.	Weight (gms.)
100-1	100.0
100-2	100.0
100-3	100.0
100-4	100.0
100-5	100.0
100-6	100.0
100-7	100.0
100-8	100.0
100-9	100.0
100-10	100.0

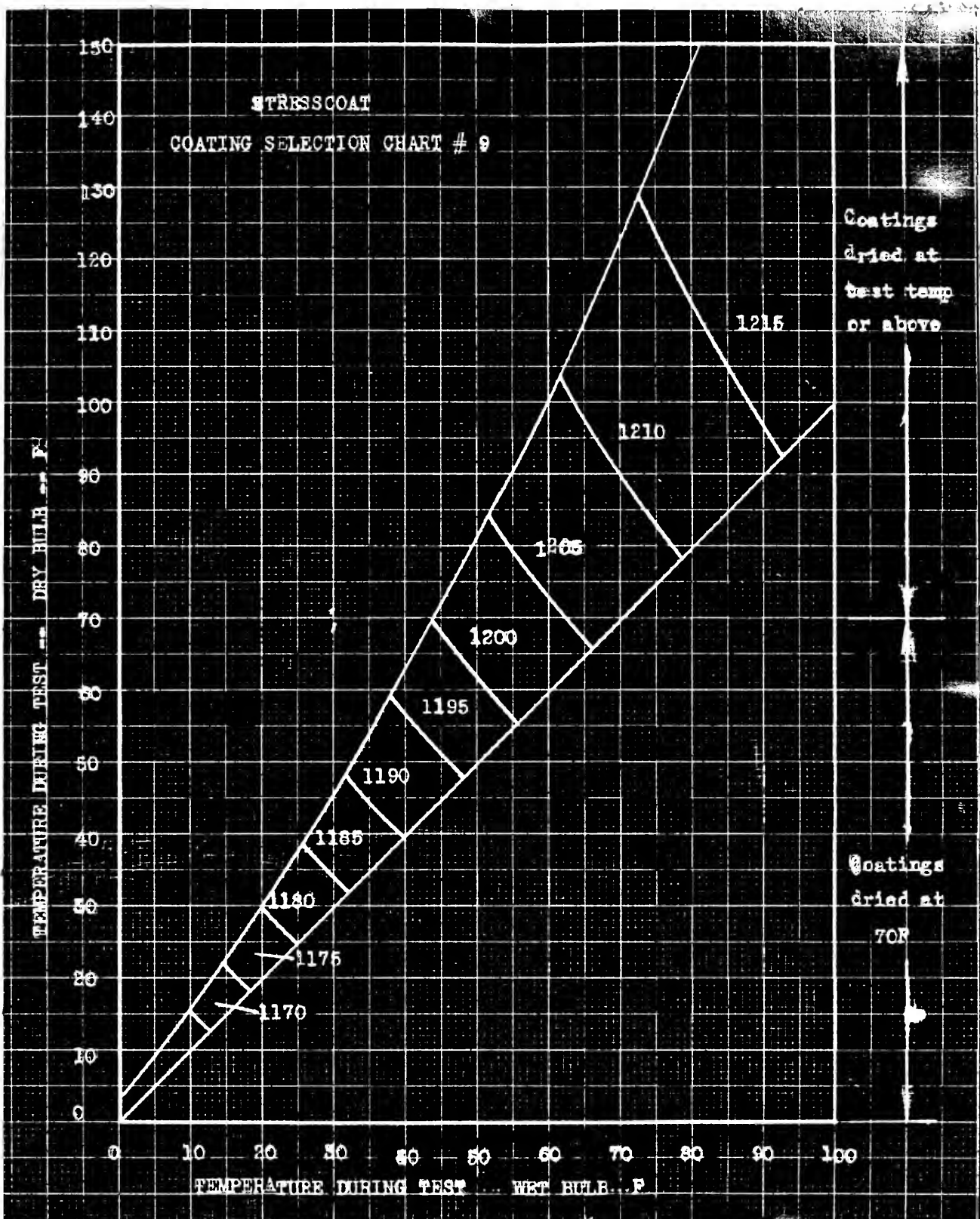
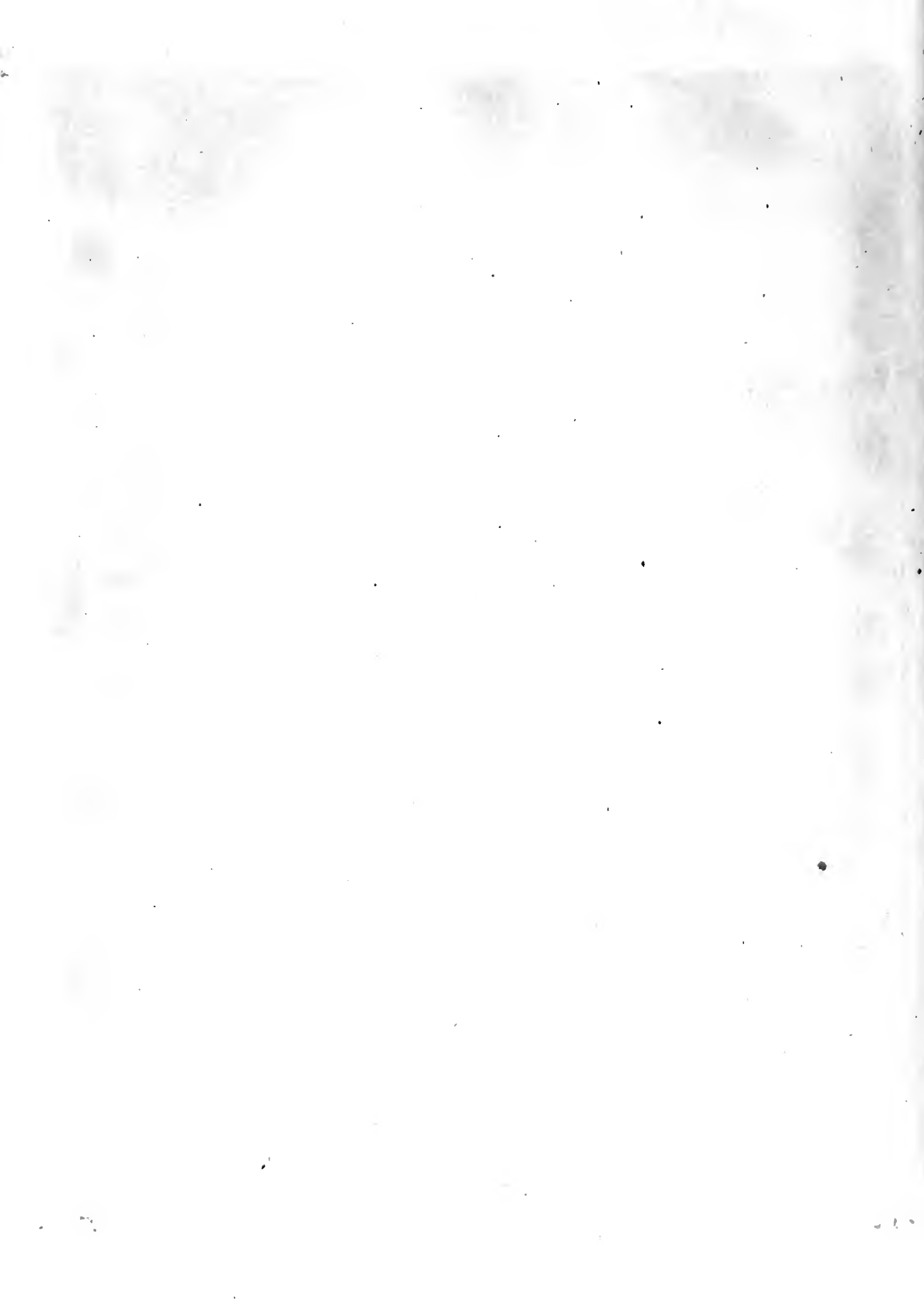


Fig. 1



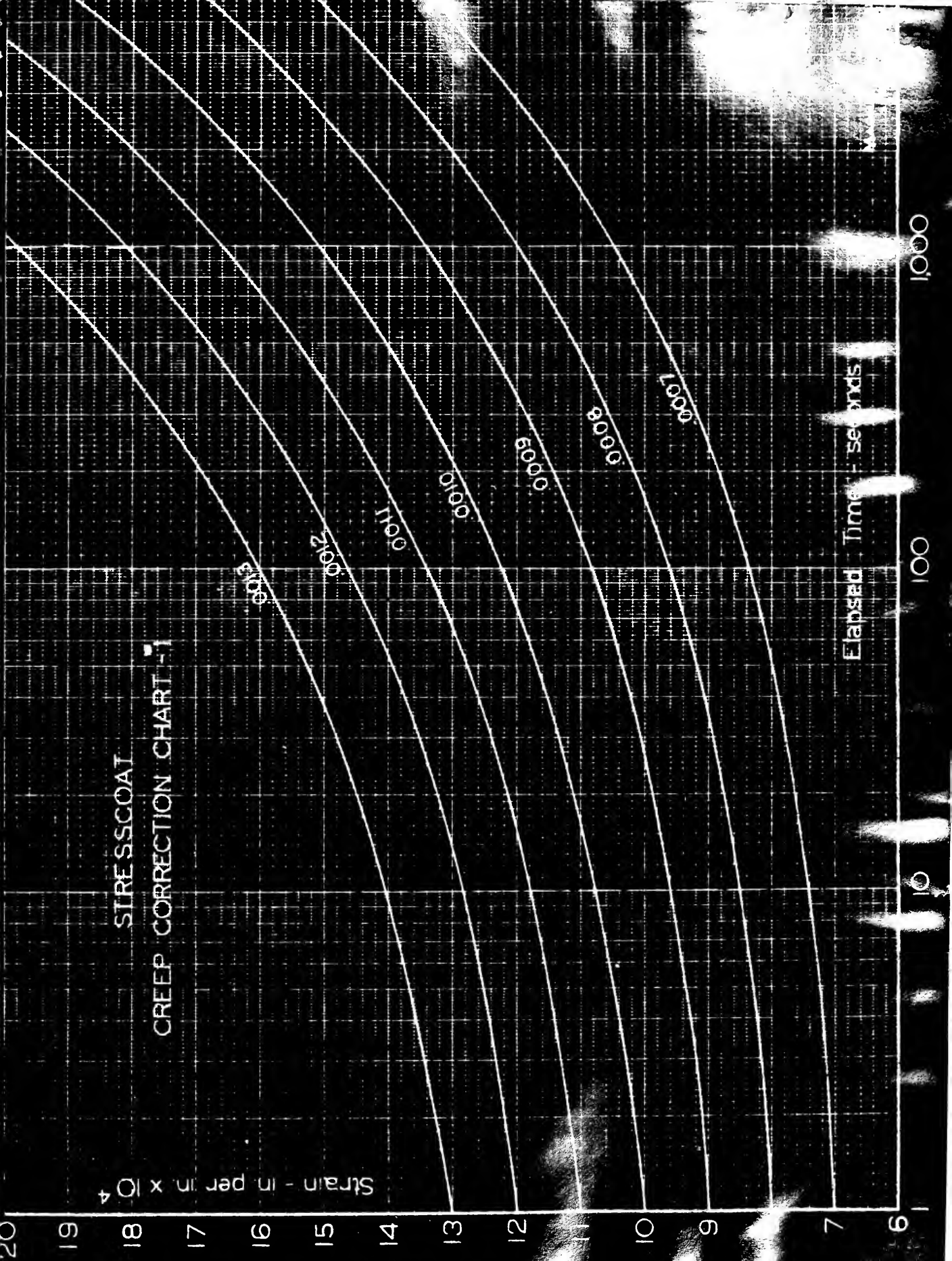


Fig. 2

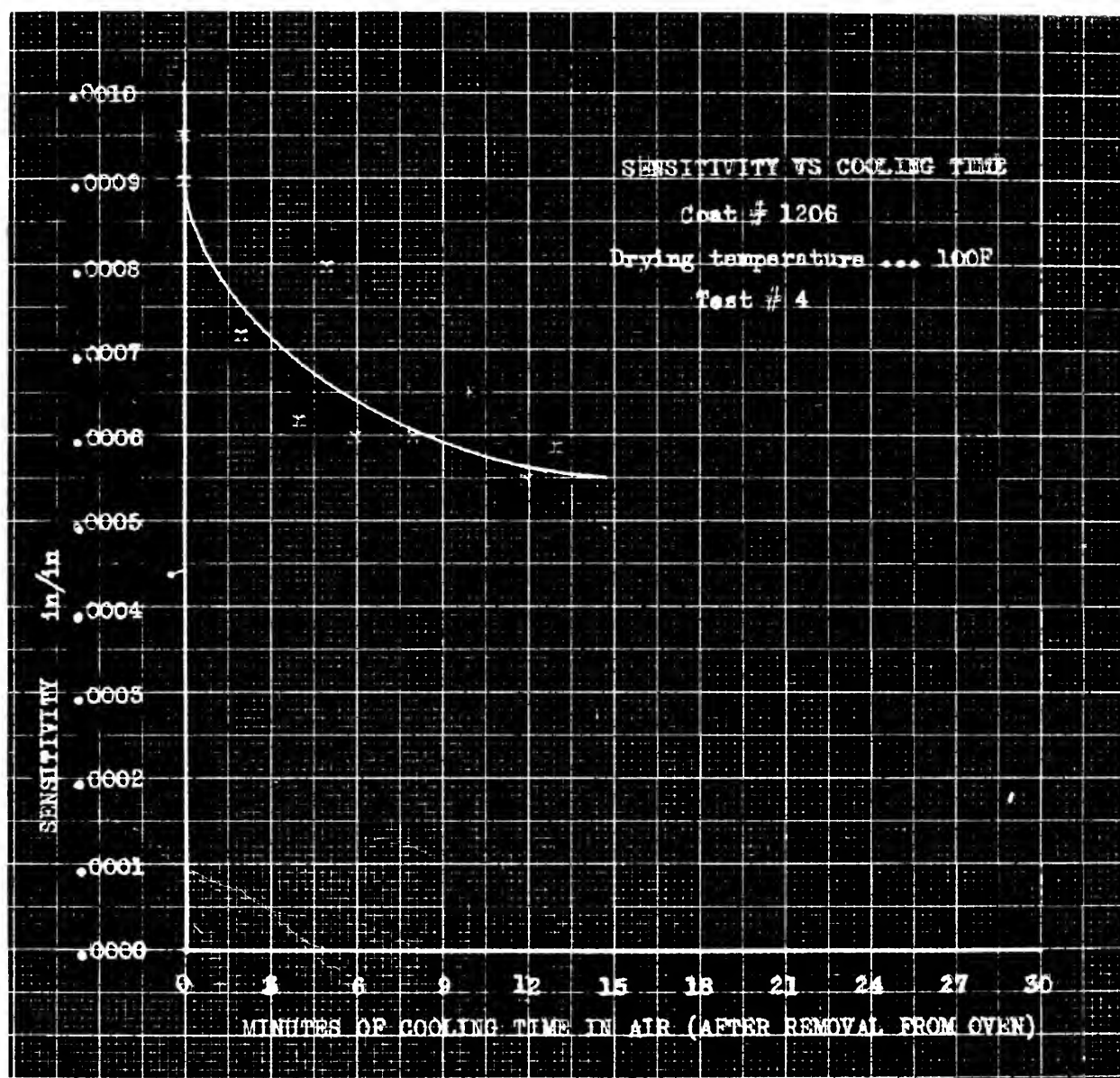
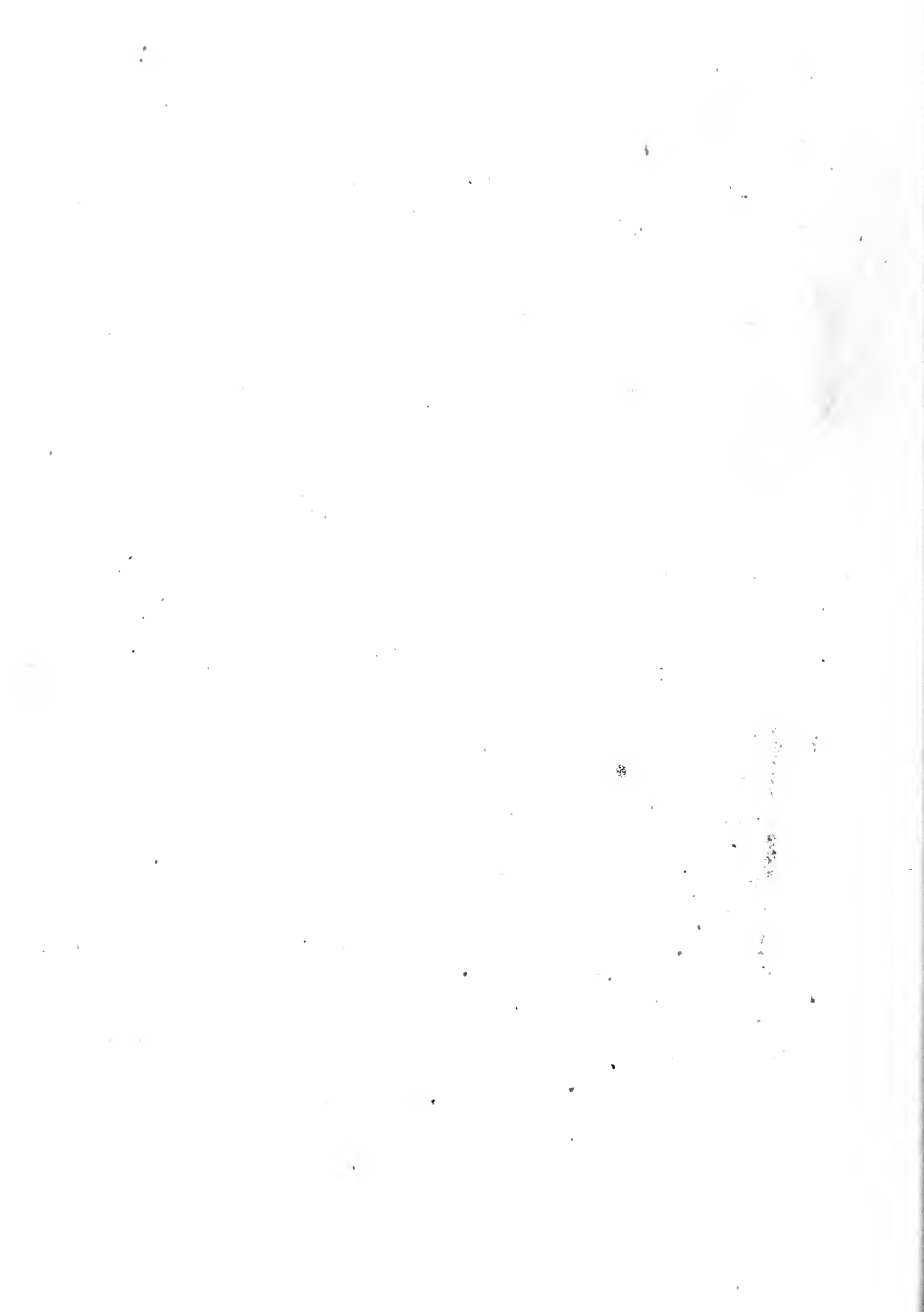


Fig. 3



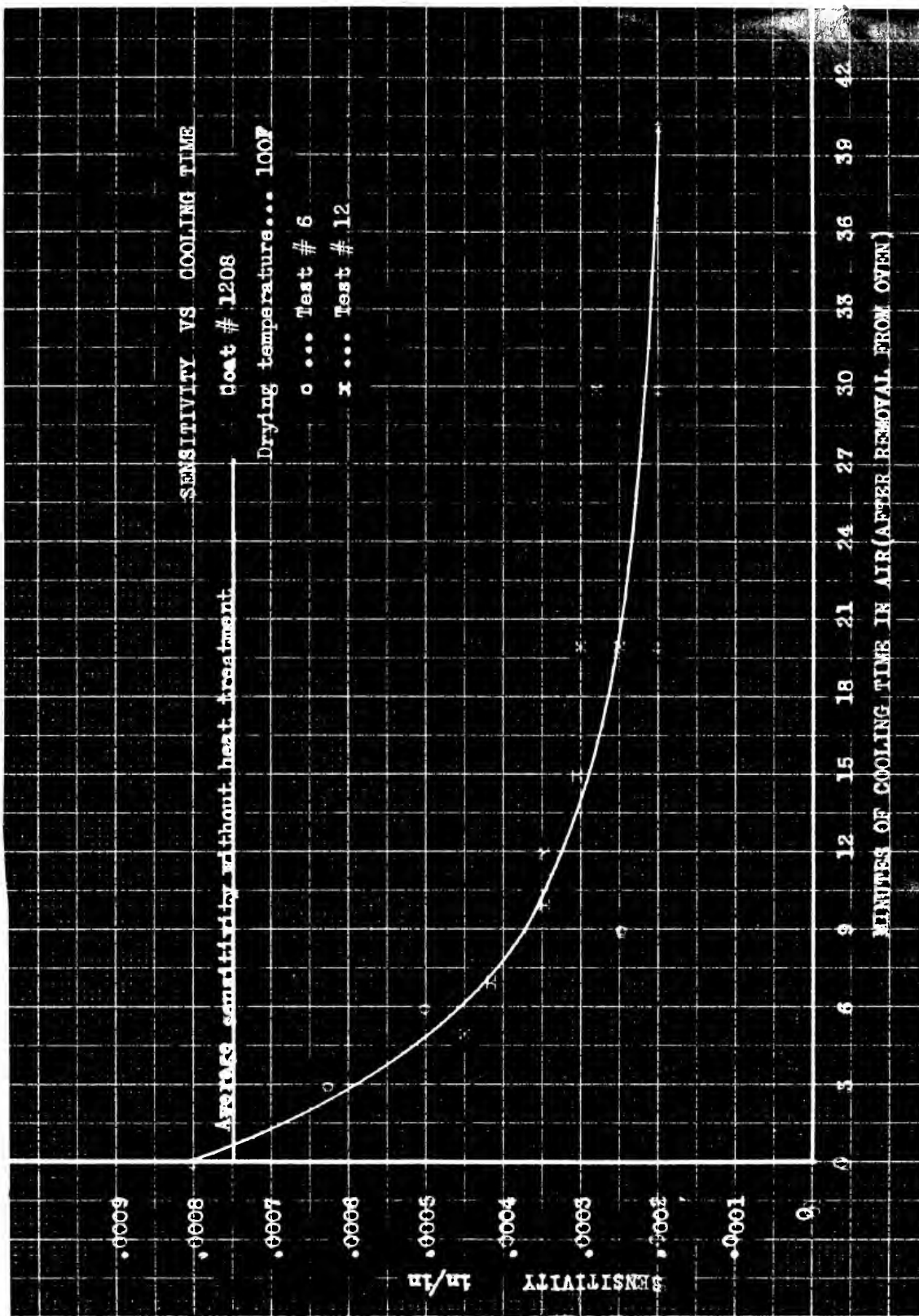
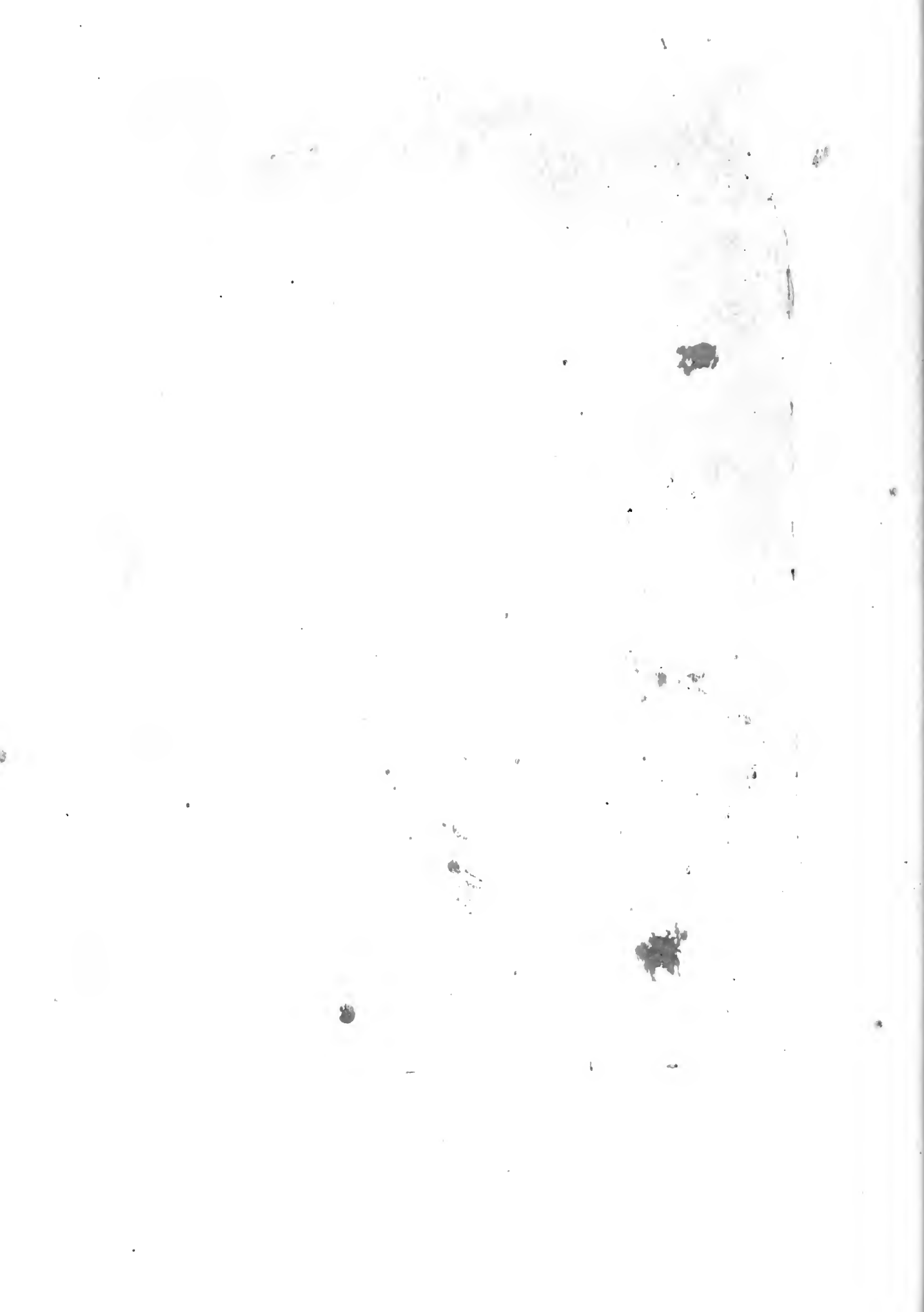
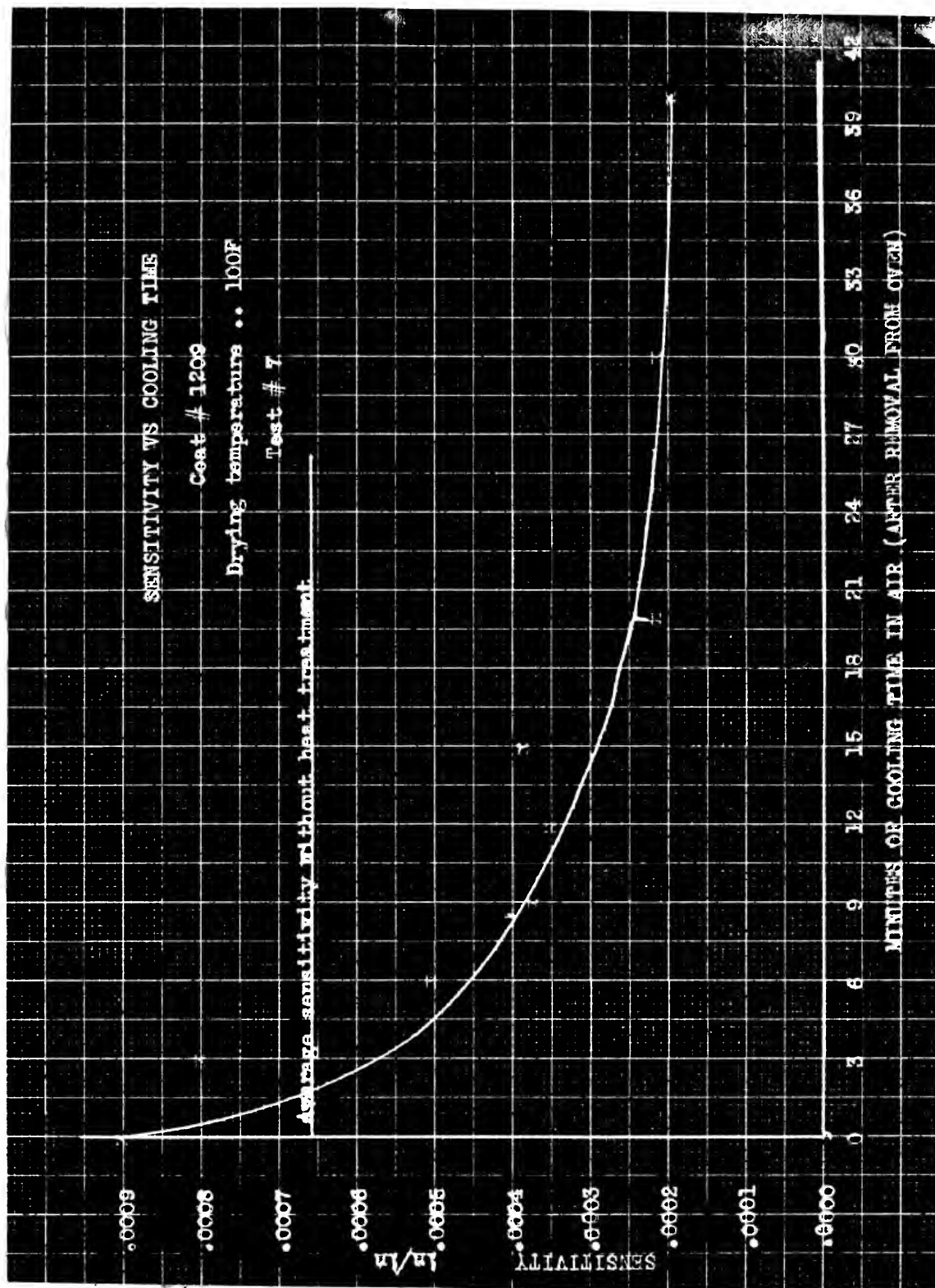


Fig. 4





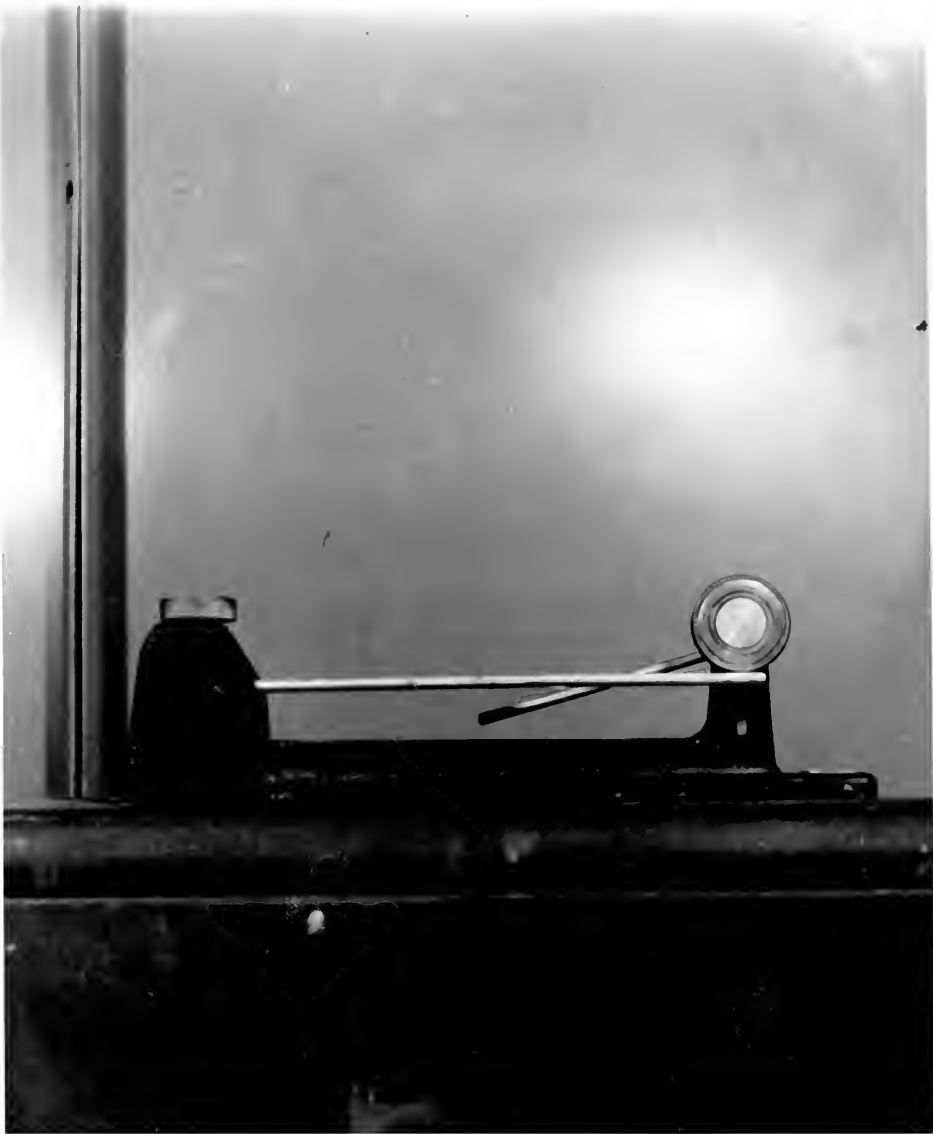


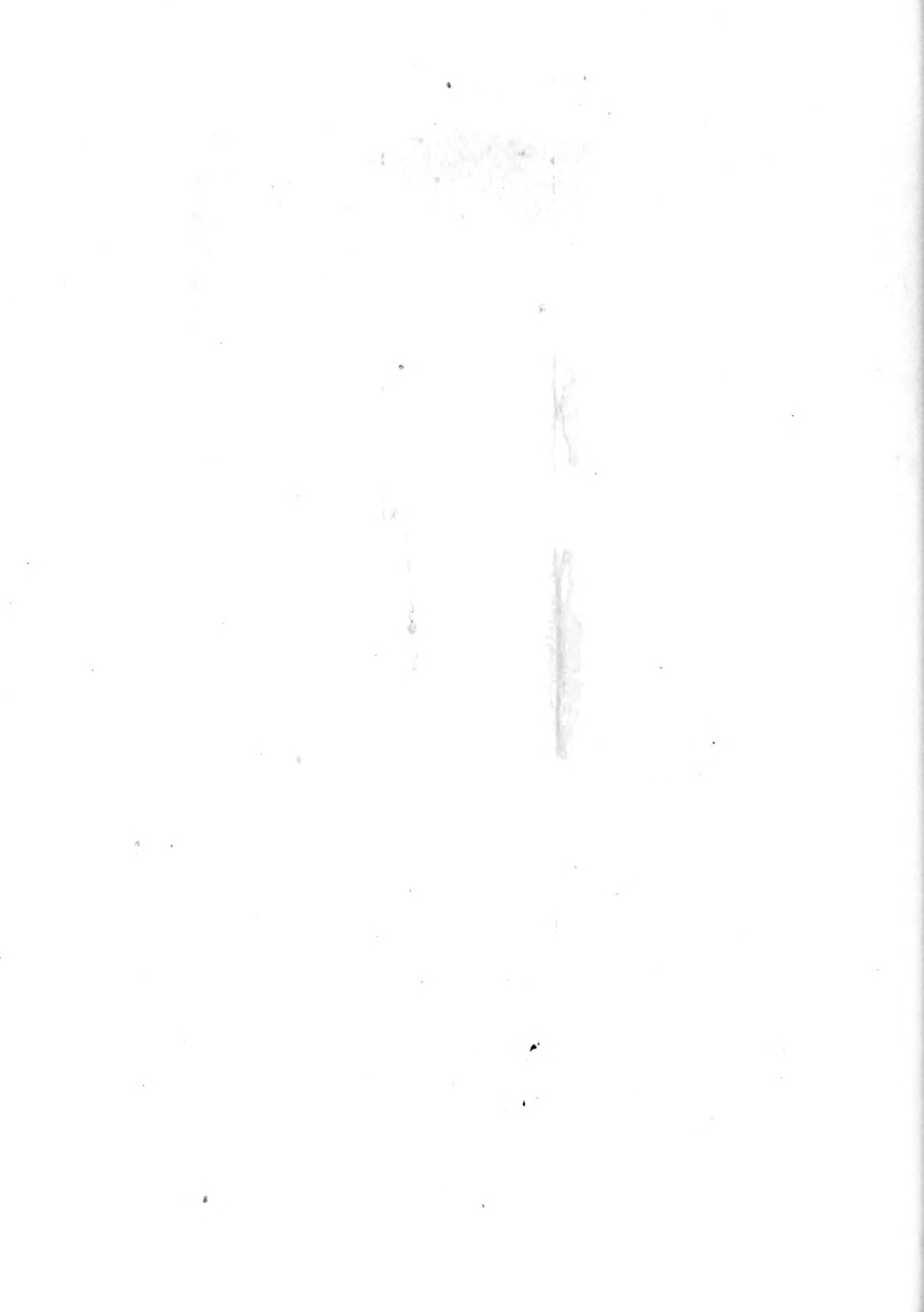
Fig. 6 CANTILEVER LOADING DEVICE

This shows a calibration bar supported at the left end, and bearing up against the cam on the right end. The adjusting screw is seen on the top of the left end. This is the unstrained position of the bar.



Fig. 7 CANTILEVER LOADING DEVICE

This shows calibration bar in loaded position. This gives known strains along bar surface.



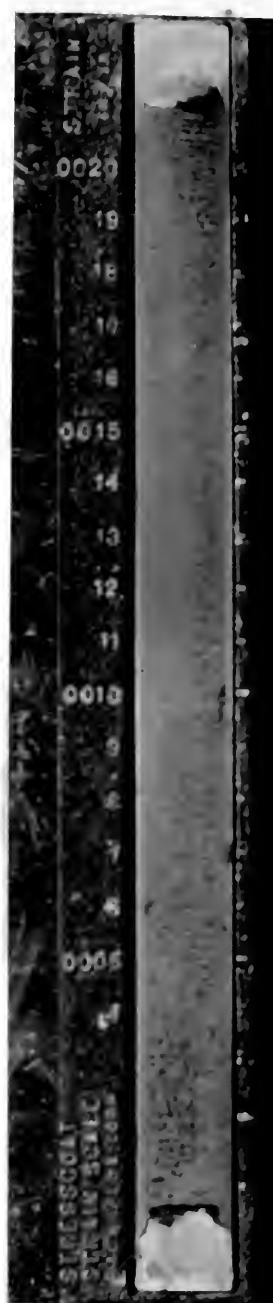


Fig. 6 CALIBRATION SCALE

This scale is calibrated to read strains along bar as caused by cantilever loading device. The bar is placed in scale as shown, and the lowest crack in the coating is a measure of the sensitivity of the coating.

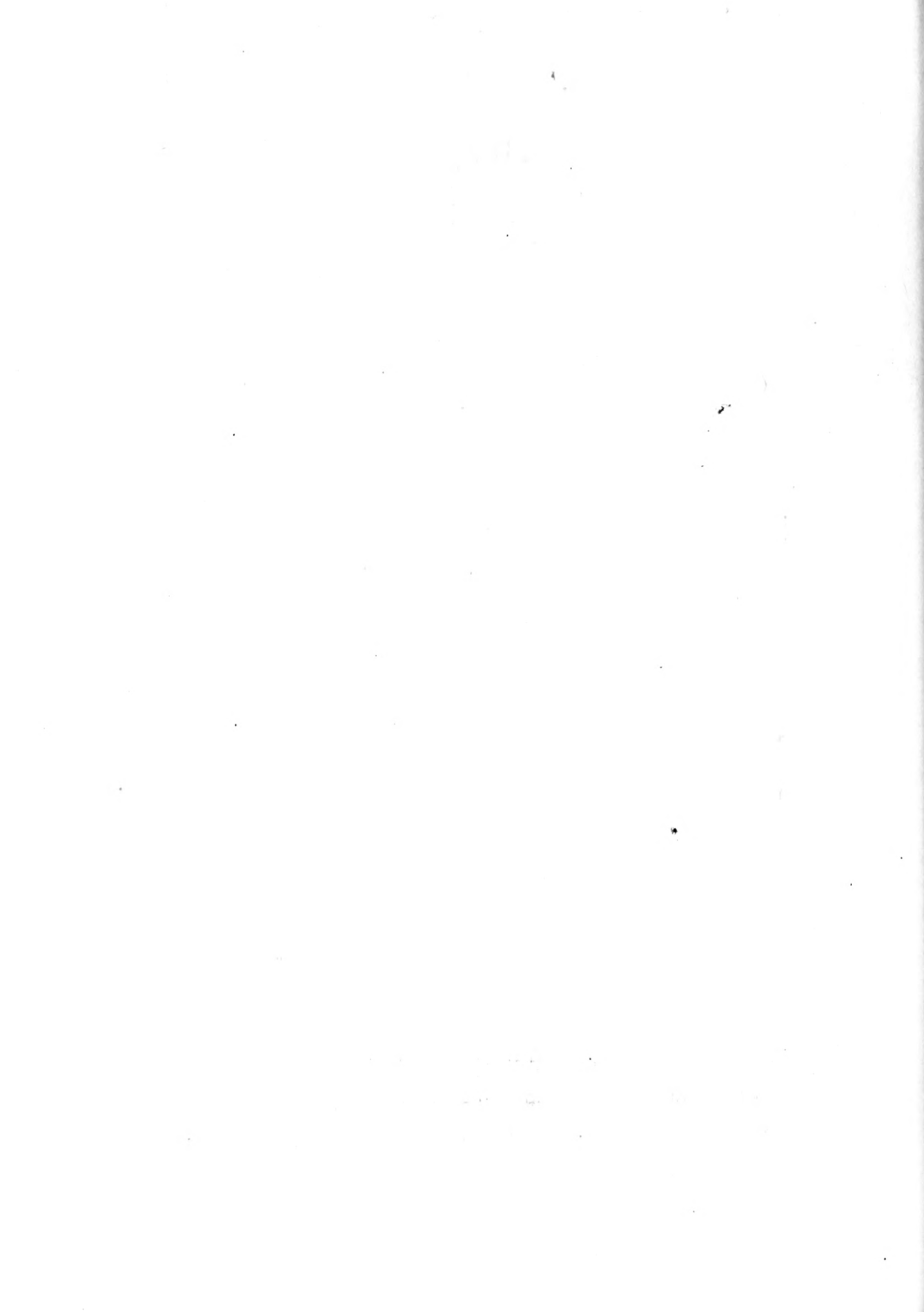
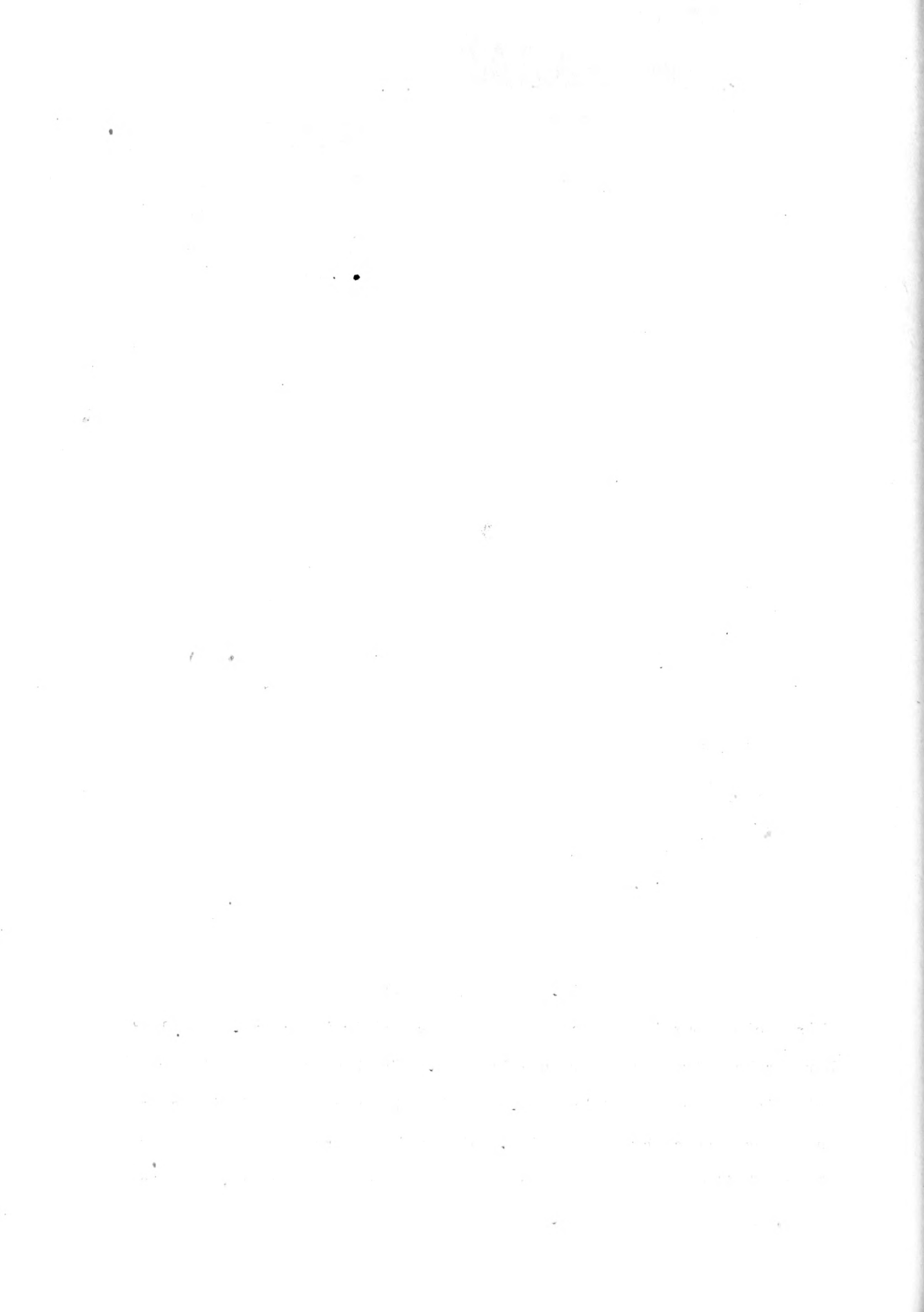




Fig. 9 DRYING CRAZE

This photo shows the effect and appearance of drying craze. The left bar was heat treated before calibration. The two on the right were dried in air before calibration. The baked bar shows no drying craze and gives good crack delineation. The drying craze on the other two almost obliterated the strain cracks giving poor appearance, less accuracy, and less sensitivity.



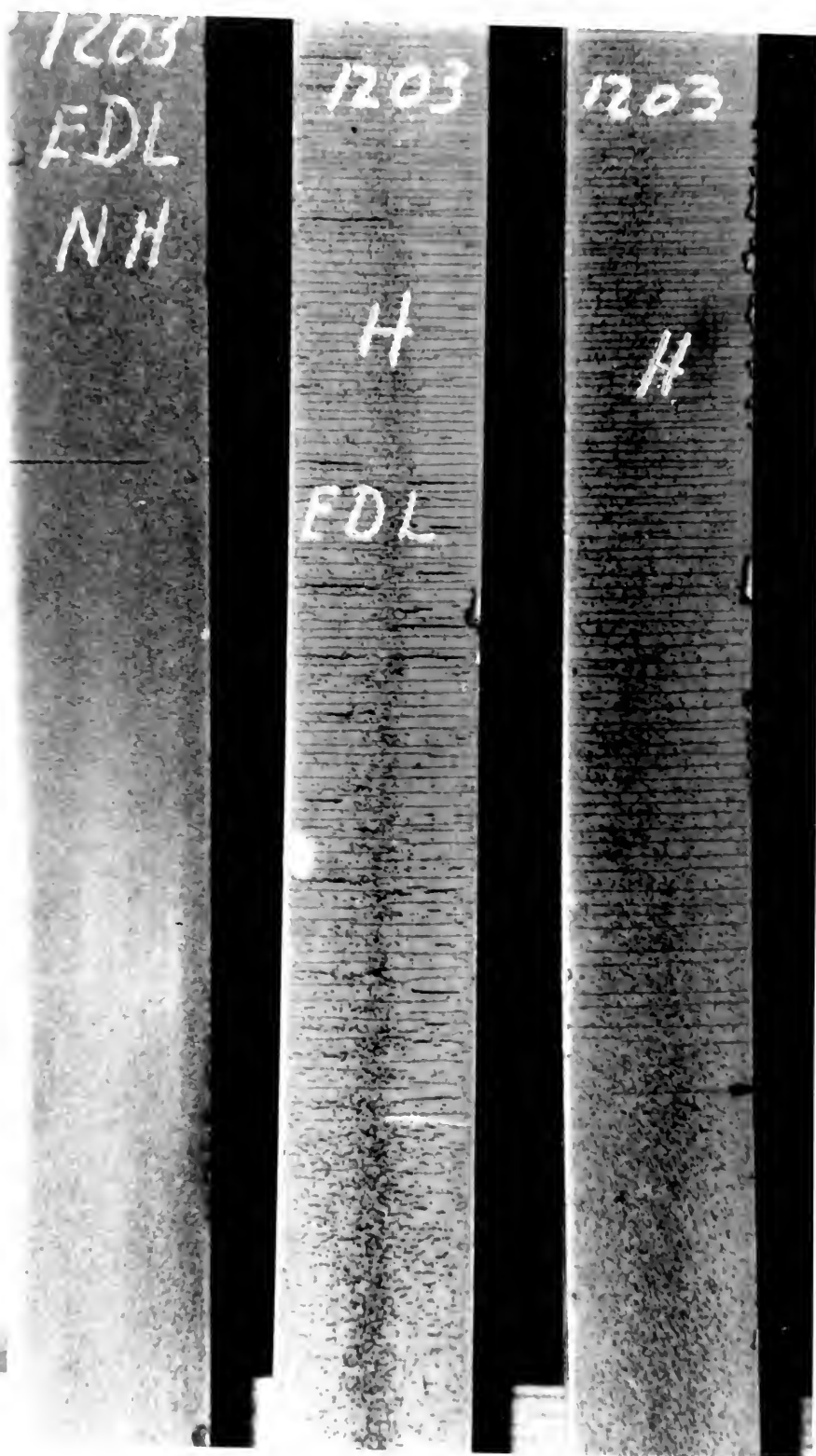
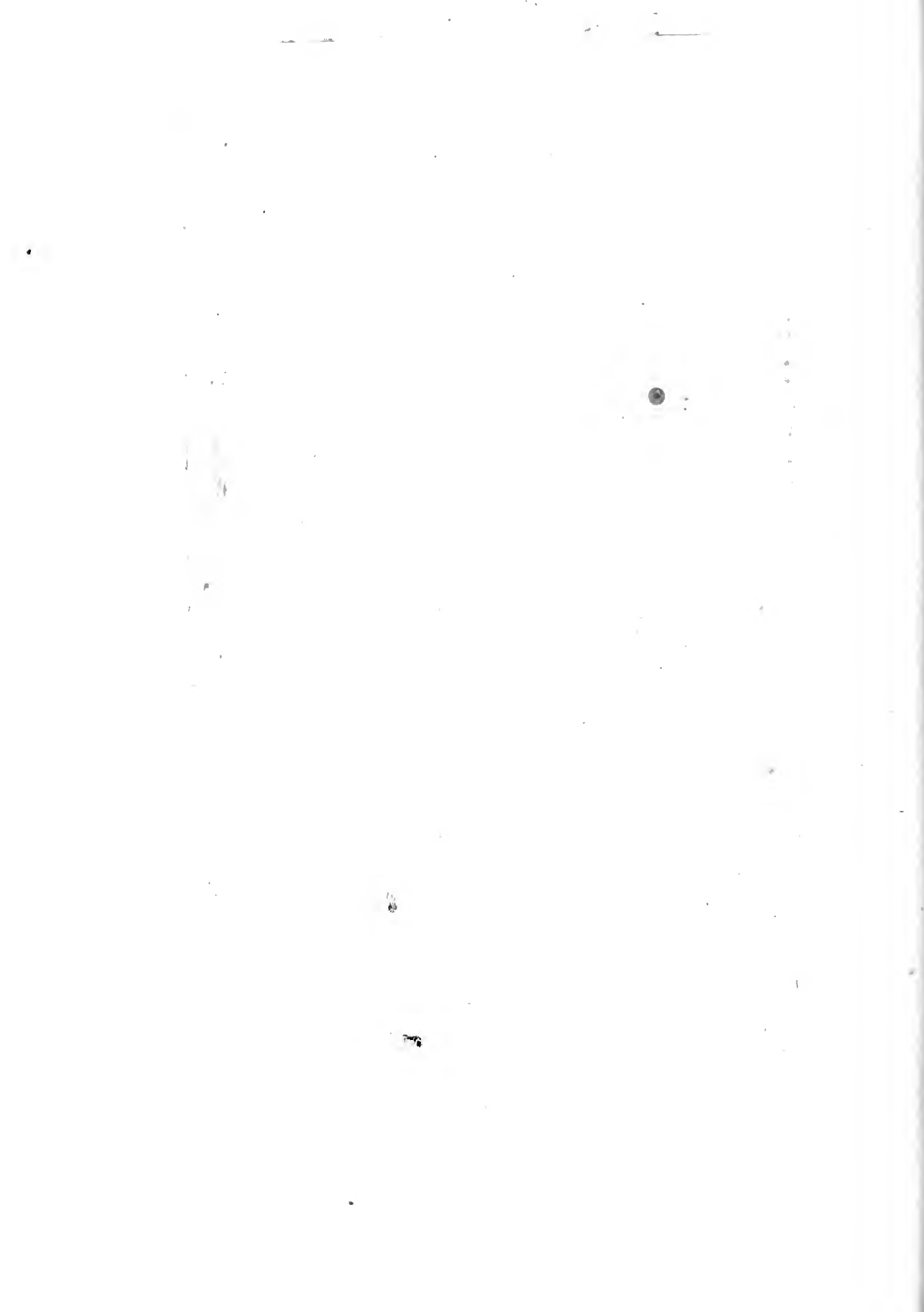


FIGURE 10

(Explanation on next page)



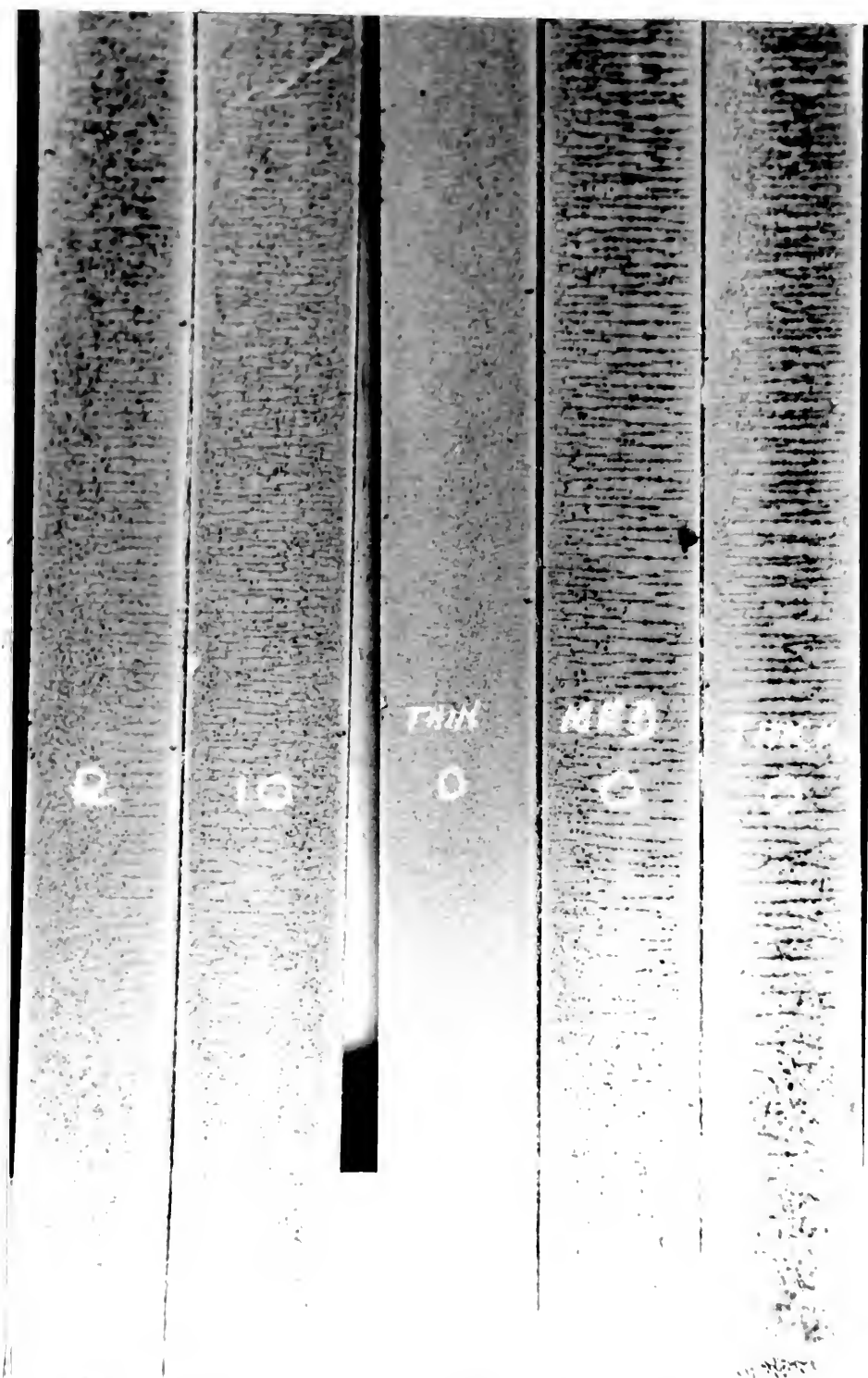
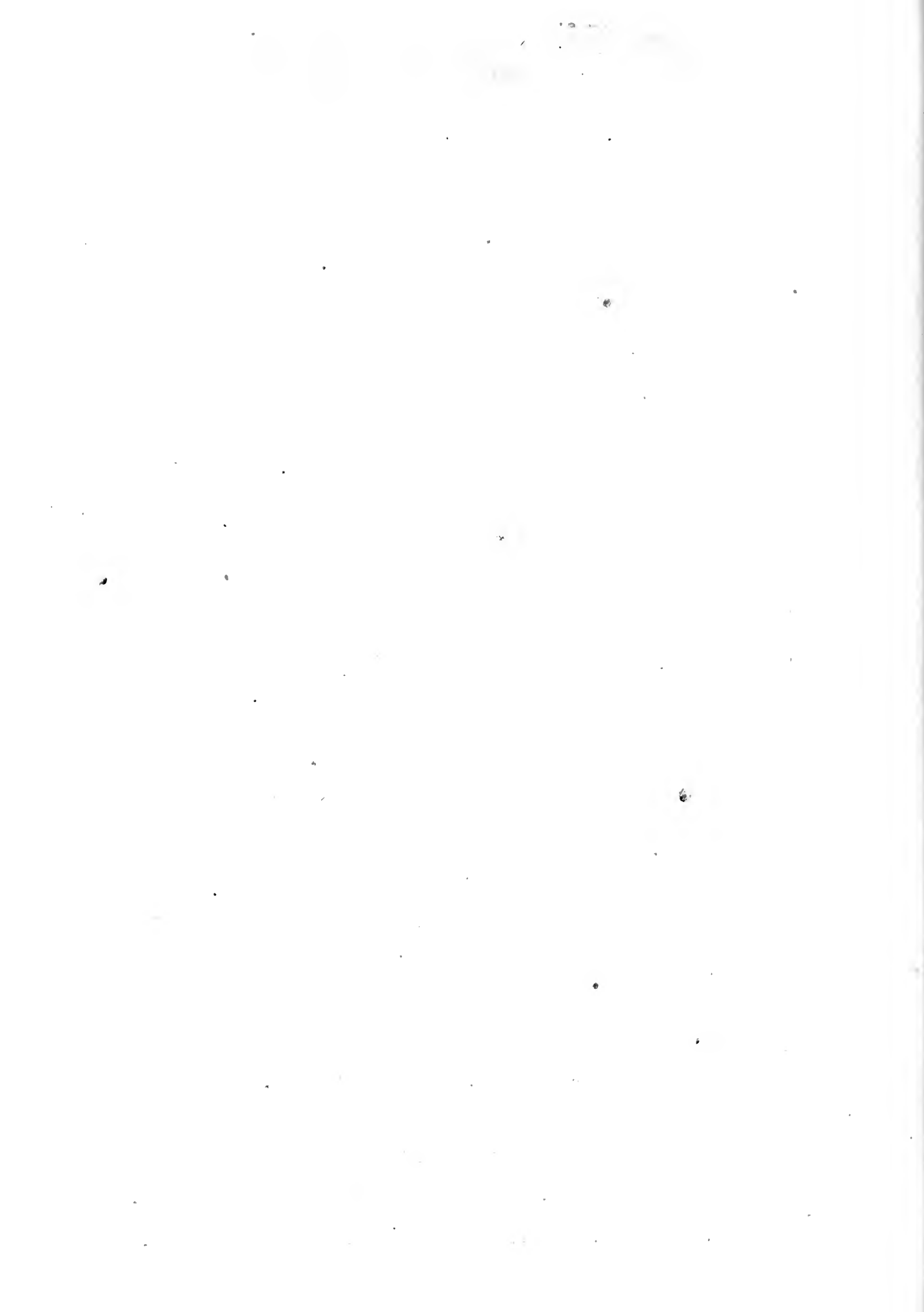


Fig. 11 VARIATION OF SENSITIVITY BY COAT THICKNESS

All bars were sprayed with coat #1203, and dried at 150 F. The thick coat gives the easiest and most sensitive reading, and the bubbles caused by heat treatment can be seen in this coat. The strip marked "R" was given light impact by dropping. Strip "10" was out of the oven 10 min. before testing, strip "R", 20min., and all others, tested immediately.



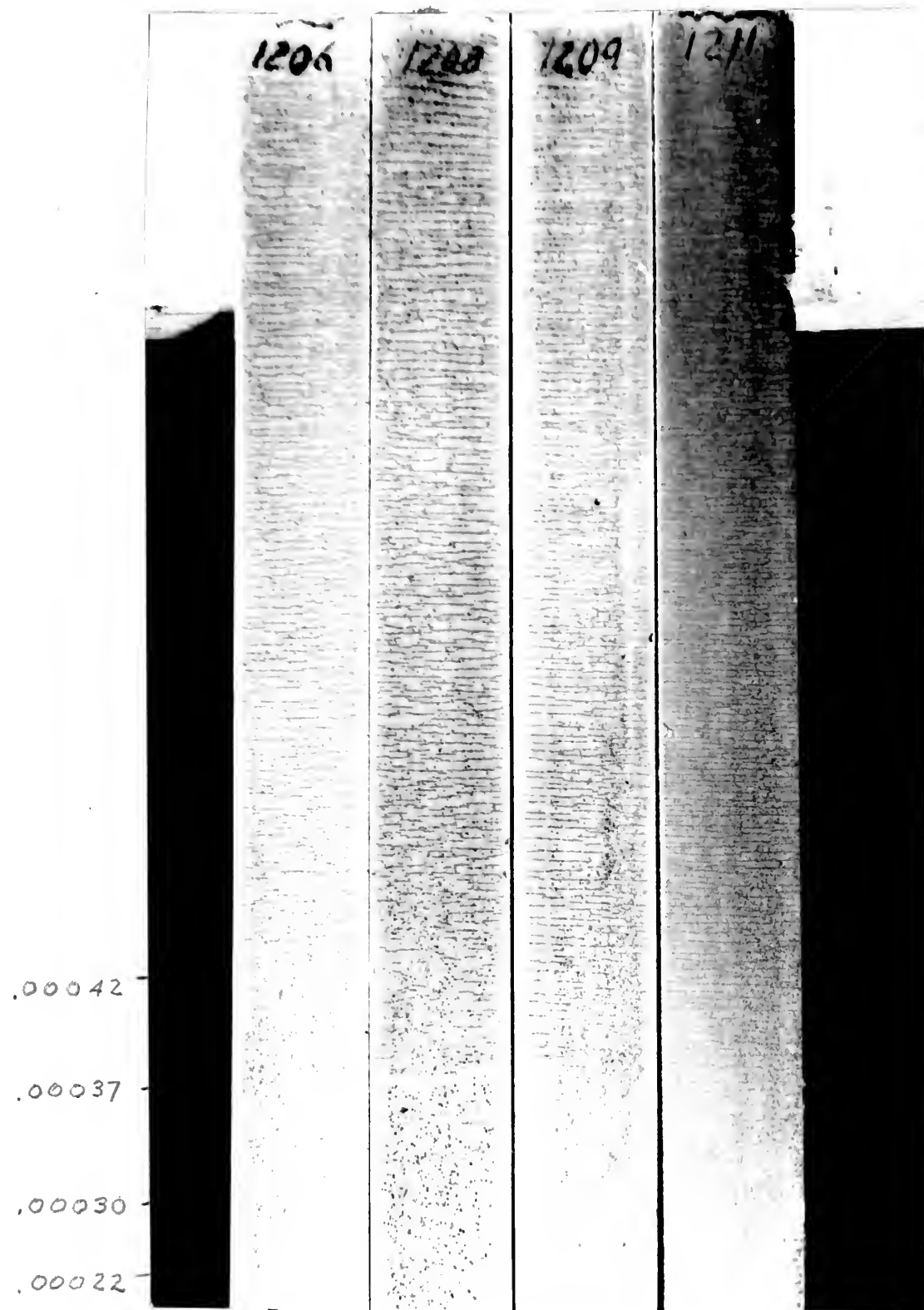
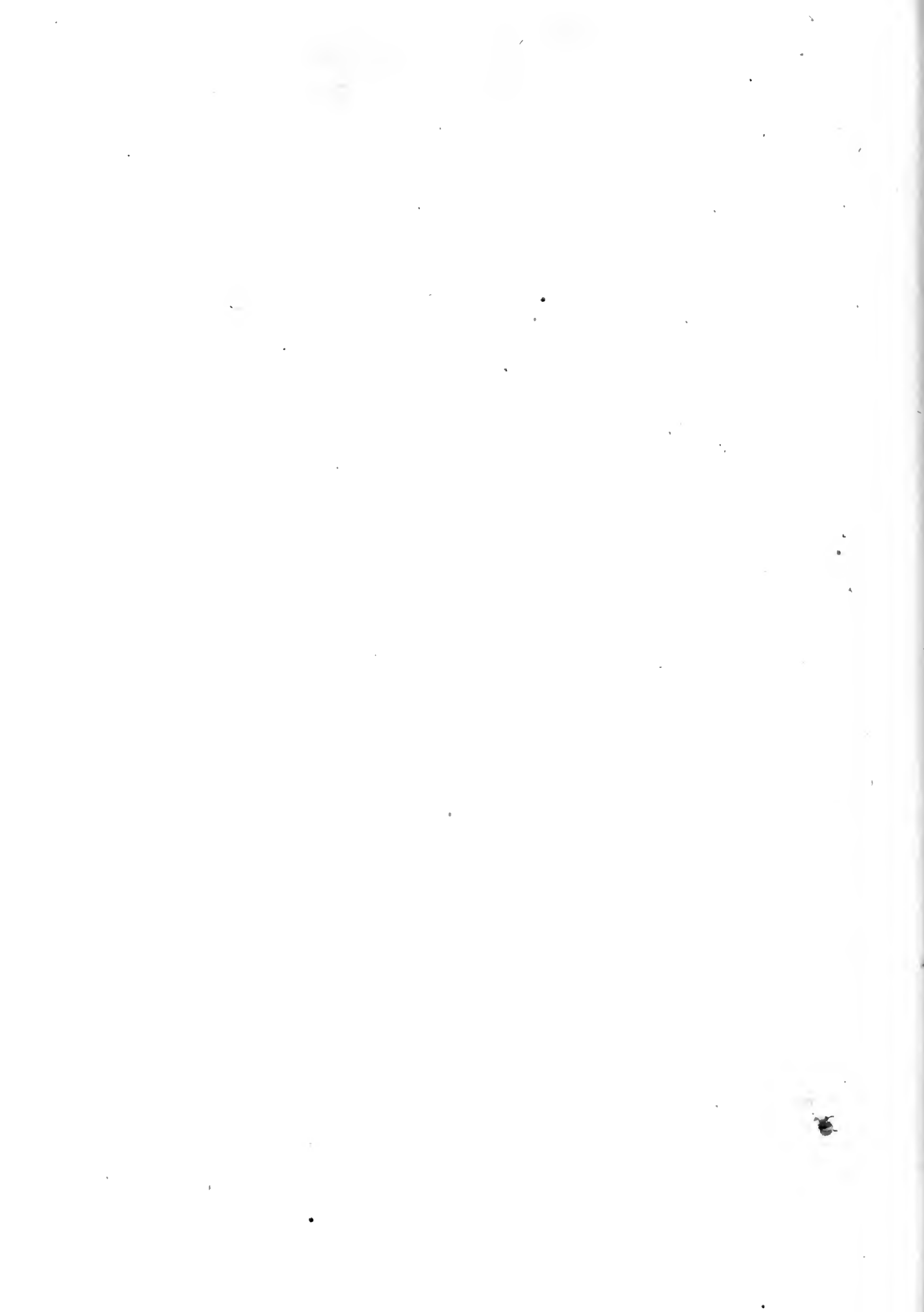


Fig. 12 VARIATION OF SENSITIVITY BY COAT SELECTION

These four specimens were dried for 24 hours at 100 F, and were cooled in air 20 minutes before testing. White marks indicate strain readings, and the values of these readings are indicated.



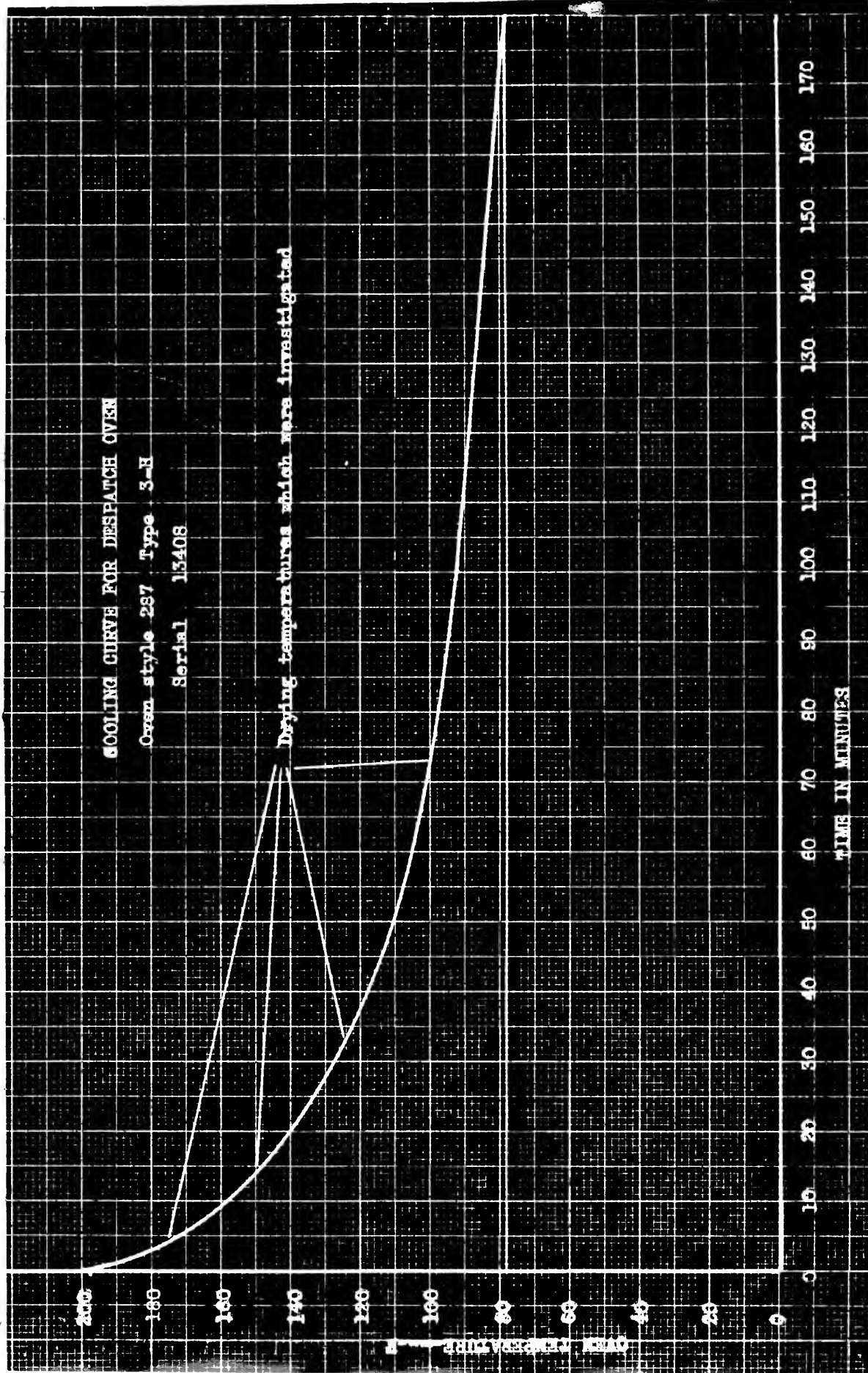


Fig. 13

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